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Electrical Units. PROF. CROCKER'S lecture on electrical units, reported elsewhere in our columns, is a most admirable résumé of a somewhat complicated subject. The dynamical system of electrical units connecting the measurement of electric energy with the measurement of all other forms of energy is, unfortunately, not as thoroughly understood by the general public as it should be, and it is a good work to call attention to the interdependence of all the magnitudes used in physical science, and the simple relations that have been established between them. One of the interesting suggestions made by the lecturer was the probable need of a practical unit for magnetic field. At present our only available unit is one line of force per square centimetre, which is much too small for convenience. In modern dynamos we should have to express the strength of field by ten or fifteen thousand units, for such is the magnetization per centimetre ordinarily employed. A convenient practical unit would be something like a thousand times the present absolute one. Only one attempt has been made to inaugurate the use of a practical unit for the magnetic field, and this, suggested by Kapp, is peculiarly inconvenient from the fact that it deals with lines of force per square inch. Now the inch is at best but a barbarous unit of length for scientific purposes, and anything derived from it not only utterly fails to fall in with our system of electrical units, but is related to them by most inconvenient multiples. By all means let us have a unit field of practical magnitude. Prof. Crocker's suggestion that it might be called a "franklin" is a very striking one, but we fear somewhat unavailable because, as the lecturer himself suggests, Franklin was not at all connected with magnetic work, and the name of the unit is far more likely to be taken from some one among the many distinguished investigators who have added to our knowledge of magnetism.

The Gramophone. AT the last meeting of the American Institute of Electrical Engineers great attention was attracted by Mr. Berliner's exhibition of the gramophone, and we take pleasure in reprinting his paper in the present issue. Among speech-reproducing instruments the gramophone is quite unique, both from its extreme simplicity of mechanism and from the extraordinary nature of the records which are obtained. The permanent record etched on zinc enables much to be done in the way of making copies of it by processes already well known, and if preserved with any sort of care the gramophone discs will last for an indefinite period. The actual performance shown in the experiments was quite satisfactory: no better, however, than can be obtained from the phonograph or the micrographophone at its best. Incidentally the etching of the gramophone records required the invention of more than one important addition to the art of etching itself, and has rendered possible, among other things, free use of the brush in preparing plates, an advantage that artists will probably not be long in appreciating.

The Baxter Street Car Motor. AMONG the various forms of street car apparatus that have so far appeared, few possess so many unusual features as that which has just been successfully tested in Baltimore. It is hard to understand why, up to the present time, designers of railway apparatus have fought so shy of the multipolar construction and the ring armature. Multiplication of poles is almost the only method by which relatively low speed and weight can be obtained in conjunction with a good efficiency, and the amount of gearing ordinarily required is so serious a matter, both as regards wear and tear and loss of efficiency, that anything which can be done to reduce it is a marked advantage. As for armature construction, the Gramme or Pacinotti ring construction is a very advantageous one where a high electromotive force is to be used. The ring armature suffers somewhat more from cross-induction than the cylinder form, but the compensating advantages are very great, especially when we contemplate the results of our present experience with drum armatures for street cars. The danger of burning out is much reduced by the ring construction that lessens the difference of potential between adjacent parts; and in so far it avoids the serious losses from damaged armatures that have been experienced by nearly every street railway in the country. With the form adopted for the Baxter motor excellent results ought to be possible, and could be missed only by bad mechanical construction of the details of the apparatus. In addition, the weight efficiency of multipolar machines is high, so that the mass of the driving machinery is much reduced; a fact that both lessens the wear of track and truck and increases the working efficiency of the system. We are glad to note the numerous good points of the Baxter machine, and trust that its operation on a commercial scale will meet the expectations which have been raised by its performance in a somewhat severe test.

The Largest Arc Lighting Station. IT gives us pleasure to describe and illustrate in the present issue an arc lighting plant that is as remarkable for its success as for its great size. Our illustrated supplement this week gives a good idea of the character of the great station of the Municipal Electric Lighting and Power Company, of St. Louis, and will teach a useful lesson to those who are contemplating the erection of important central stations. Not only is this plant extraordinary for its immense size, but its performance from the day of its inauguration has been highly satisfactory. By the contract with the city rebate is allowed for every light extinguished, or imperfect, and the amount of this has aggregated to less than one per cent. of the total service, a record of which many smaller and more easily managed stations might be proud. The general arrangement adopted in St. Louis is one which has found favor in many cases of city work. The dynamos are placed on an upper floor, the engines and boilers below. The feature of the St. Louis plant, however, is the shafting room; the very large Corliss engines which are used are belted on the main line shafts, which occupy a long hall by themselves, and from which the belts rise through the ceiling to operate the dynamos. In some respects this arrangement is not without its faults, but where the cost of land is high placing practically the whole plant on a single floor is too expensive and recourse has to be taken to methods like the one we are considering. An interesting minor point in the operation of the system is the use of oil for fuel on a large scale. This has increased the capacity of the boilers and lessened the amount of care required, so that the oil fuel is a rather successful competitor of coal, even at the low price at which the latter can be furnished. The principal point to criticise in the plan is the use of simple engines instead of compound or triple expansion machines. There are 10 great Corliss engines capable of handling an aggregate load of 8,400 arc lamps. For a plant of this magnitude it almost goes without saying at the present time that compound condensing engines are a very considerable advantage and the more recent stations are generally being equipped with them. Much of the success of this St. Louis plant is due to the great skill with which the details have been worked out, and with which all the minor operations are conducted. A complete system of checks, testing every portion of the apparatus and watching its performance are in regular use, and have added much to the freedom from minor difficulties which has been secured. Outside of the station the same watchfulness is exercised. The trimming of the lamps is greatly simplified by means of the little trimmer's cart, which has been introduced, and the work of replacing the carbons is carried on with great rapidity and at much less expense than is usually met. In addition careful reports from all the trimmers are required, so that the superintendent of the station can, at any time, know exactly the condition of every part of this immense plant, just what repairs, if any, need to be executed and what portions of the system must be looked after to avoid trouble. By thoroughly systematic administration of the work it has been possible to conduct it with a degree of economy that was scarcely to be anticipated, and it must be said that the colossal station is in every way a first-class working success. We cannot do better than commend our readers to the careful study of our very elaborate description of this immense lighting station.

Electric Street Railway Patents. DURING the last three or four years there have been wars or rumors of wars continually among the street railway companies. Threats of suits and counter-suits have been flying about in the most promiscuous fashion, and meanwhile the companies have been using pretty much what apparatus suited their fancies. Just now the daily press has been calling attention to the threat of an electric company in St. Louis to establish its claims at the expense of the rest of its kind. The two patents on which the claims are based are both for motor trucks, in which the armature and fields are both centered around the car axle as a common axis. But how far this construction with the accompanying intermediate gears carried by frames attached to the axle preempt the ground that has been covered by the method of truck construction adopted in recent practice remains for the courts to determine. The early history of electric railroading is just at present exceedingly foggy. Claimants to fundamental patents are almost as numerous as original inventors of the telephone were a few years ago, and their respective alleged rights will at least furnish a magnificent series of litigations if any attempt is made to enforce them. The early patents of Field have attracted no little attention on account of their close relation to the fundamental methods involved in electric traction, but up to the present they do not seem to have deterred any one who pleased from using the generally adopted devices for electric cars. The present claimant aims its attack not at the general principles involved in the Field patents, but at that most important item in practical success, suspending the motors from the axle. The claim is not only important on account of its possibly involving the ordinary construction of motor truck, but from its application to the case of slow speed motors put directly upon the axle. The solemn truth to tell, there has been among electrical companies a somewhat peculiar code of ethics regarding patent rights, and the legal process of establishing them seems to have been in a large measure abandoned, much to the detriment of the feelings and pockets of the lawyers, in favor of the somewhat aboriginal but effective plan of retaliation. The result of this reversion to first principles is that a very large number of nearly identical details can be found in all the electric railway systems, and instead of paying tribute to each other they are working side by side to develop the common field of operations. Just what the outcome of it all will b it is quite impossible to predict, but the immediate result has been to extend the electric railway in a fashion that would scarcely have been possible had any one company succeeded in establishing an exclusive right to any necessary part of the usual system. Patent rights there are undoubtedly, but until the present they have been held very much in abeyance, and if the proposed suits just mentioned, attempting to involve fundamental principles, are carried to any termination at all, it will be quite unique in this particular branch of litigation. There must have been, of course, original inventors of the principal features of electric traction, but their respective rights and privileges have been pretty thoroughly mixed up and cross-connected. Unlucky the wretch who attempts to bring order out of the chaotic mass of claims. And if the American inventors should eventually succeed in defining their relative positions in the history of the art, there is always that pleasant possibility that was so beautifully exemplified in the case of the laminated armature, to wit—the malevolent machinations of certain never-to-be-sufficiently-objurgated foreigners who were unkind enough to describe the devices in litigation some years prior to the first American claims.

Latest] Foreign Electrical News.

(By Cable from our Regular Correspondent.)

London, Dec. 29, 1890.—A committee on electrical standards has been appointed by the Board of Trade, consisting of Prof. Sir William Thomson, Lord Rayleigh, Prof. Carey Foster, Prof. Glazebrook, Prof. John Hopkinson, Prof. Ayrton, Mr. Preece, Mr. Grove, and Major Cardew. It is expected that this committee will recommend to the Board of Trade to adopt the new ohm recommended at the British Association as the legal ohm, and that an act of Parliament should be passed to that effect. It will be remembered that the ohm just mentioned is the resistance of a column of mercury one square millimetre in section, and 106.3 centimetres long at zero degree centigrade. Inasmuch as there was no parliamentary action on the present so-called legal ohm, the adoption of the new standard will be by so much the more easy.

The fogs during the past week have most severely tested the resources of the London electric lighting systems; only one partial failure has so far occurred, that of the Chelsea Company, which employs accumulators.

The City & South London Railway performed admirably during the first week of its operation; the continued bad weather interfering with surface traffic increased its receipts enormously, and has given the public confidence in its powers.

Electrical World Portraits.—XX.

PROF. CHARLES R. CROSS.

The long connection of the subject of this sketch with the Massachusetts Institute of Technology has made him a familiar figure in the scientific world, so that a notice of his life and admirable research work will be of decided interest to the readers of The Electrical World.

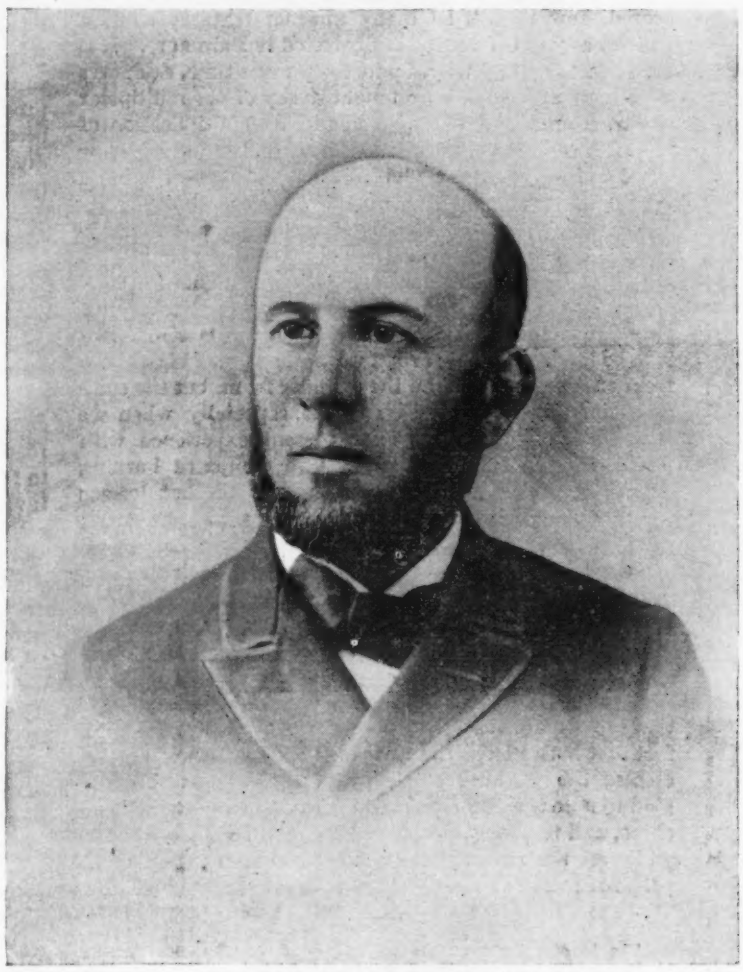
Charles Robert Cross is a native of Troy, N. Y., where he was born some 42 years ago. The family name is a familiar one in New England, and has been well known in Essex County, Mass., for many generations. In 1862 Mr. Cross removed to Newburyport, Mass., and it was there that his technical education began. After graduating from the local high school he decided to enter upon that academic career which he has successfully pursued, and after teaching in the Bartlett High School, New London, Conn., for a year, by way of practice, he entered the then newly established Massachusetts Institute of Technology and devoted himself while there to the study of physics under Profs. Rogers and Pickering. In 1870 he graduated, and was immediately thereafter appointed instructor in physics, and in 1875 professor of the same subject; and when Prof. Pickering resigned in 1876 Prof. Cross took his place at the head of the department of physics, and has held that position ever since. The decade from 1870 to 1880 was largely occupied in the routine of teaching work, and in building up and enlarging the courses of lecture and laboratory instruction in pure physics. It was only during the latter part of this period that Prof. Cross' research work brought him prominently to the front. He has always been especially interested in the study of acoustics, and from this was led into special investigations of the telephone and its development. It was by this means that Prof. Cross came to fully realize the great need of technical instruction in electricity; and in 1881 he began to devote an unusual amount of attention to this branch of physics, and gave an extended course of lectures on practical electricity. In the following year the first course in electrical engineering in this country was instituted at his request, and since that time the Massachusetts Institute of Technology has been prominent in the field of electro-technical instruction.

In forming its initiative course there was, of course, no precedent to guide for either class-room or laboratory instruction, but the scheme first drawn up worked so successfully in practice that none of the leading features have needed alteration, although the development of the subject has lead to important additions to the course.

Prof. Cross is as well known a lecturer as a writer, for nearly every year since 1872 he has given a course of lectures on some branch of physics at the Lowell Institute. Of late years these have mostly been of a technical nature, and have attracted wide attention from their clearness and admirable experimental illustrations.

Glancing at the various researches which have been added to scientific literature by Prof. Cross, one finds a brief history of the way in which he has been led through acoustics and the study of its applications to electricity. The following list will give a general idea of the more important of Prof. Cross' investigations, and shows better than any words could do the untiring industry that has enabled him to do so considerable an amount of work in spite of the calls of routine instruction upon his time.

Prof. Cross is a Fellow of the American Academy of Arts and Sciences, of the American Institute of Electrical Engineers, and of the American Association for the Advancement of Science. As an instructor his record has been a most enviable one, and few scientific men have been more thoroughly popular among their students or more widely and favorably known to the community in which they lived. Among the numerous papers which Prof. Cross has contributed to the scientific journals and periodicals named above, and to others both in this country and in Europe, may be mentioned the following: "On the Focal Length of Microscopic Objectives," "Helmholtz's Vowel Theory and the Phonograph," "Permanent Record of Foucault's Pendulum Experiment," "On the Present Condition of Musical Pitch in Boston and Vicinity" (written in conjunction with Mr. W. T. Miller), "Barometric Measurements of Heights: Annual address of the President of the Appalachian Mountain Club." "Notes on Acoustics: 1. Quality of sound as related to change of phase; 2. Remarks on a point in Helmholtz's Theory of Consonance and Dissonance; 3. Intensity of sound, as related to amplitude of vibration; 4. On a musical application of the principle of fatigue." "Hartleben's Library of Electrical Technology," "Experiments with the Thermal Telephone," "Measurement of the Strength of Telephone Currents," "Experiments on the Melting Platinum Standard of Light," "The Inverse Electromotive Force of the Voltaic Arc" (written in conjunction with Mr. W. E. Shepard), "Researches on Microphone Currents," by C. R. Cross and A. W. Sabine; "The Strength of the Induced Current with a Magneto Telephone Transmitter as Influenced by the Strength of the Magnet," by C. R. Cross and A. S. Williams; "On the Extent of the Excursion of the Electrodes of a Microphone Transmitter," "On the Influence of the Strength of the Magnet in a Magneto Telephone Receiver," by C. R. Cross and H. E. Hazen. Besides the production of these papers Prof. Cross has, in conjunction with other workers, accomplished a large amount of original investigation that has attracted the attention of scientists in this and other countries.



PROF. CHARLES R. CROSS.

Notes on the Economy of Electric Lighting.

BY DR. LOUIS BELL.

A few years ago there were very grave doubts in the minds of the majority of people concerning the possibility of really economical lighting by electricity; it was even said that while the quality and quantity of electric light would leave little to be desired, it could not be produced at a price to compete on favorable terms with gas. At this time such a statement would be immediately recognized as fallacious, for there are very many places where electric energy is sold at a price that puts gas quite in the background as an economical illuminant. A 16 c. p. electric incandescent light is the equivalent of a five-foot gas jet consuming the average quality of gas. In other words, we can in making a comparison between these two artificial lights reckon 200 electric lamp hours as the equivalent of 1,000 feet of gas. Consequently at the prevailing central station rate of one cent per lamp hour electric lighting costs an amount equivalent to $2 a thousand feet for gas, while it possesses the great advantage of giving out relatively little heat and burning no oxygen out of the air. At the generally prevailing price for gas the two illuminants are so nearly on an equal footing that small accidents of situation are enough to control the question of relative economy. But it is not my purpose to discuss the somewhat worn question of electricity vs. gas, but to call attention to what can be done in the way of domestic lighting by electricity, even when it has to compete with kerosene lamps. It may appear somewhat absurd to take the position that kerosene may in many cases cost as much as, or more than, electric lighting at the usual rates; nevertheless such is the fact. Of course where one is content with a comparatively small amount of light not at all equivalent to what would be secured by electricity or gas, the oil lamp owns no competitor, but if the problem in hand is to light a residence in a thoroughly satisfactory manner the conditions are very much changed. I shall take a concrete case drawn from my own observation, by way of illustration. The field of operations was a 10-room modern house in a suburban town, occupied by half a dozen adults. The lighting throughout was by kerosene lamps, 13 being in regular use, part of them having duplex burners, the others the simple flat wick. During a period covering the latter part of November and the first half of December 52 gallons of oil were consumed in 24 days. The price of oil being 13 cents per gallon, the daily cost of illumination was a small fraction over 32 cents. It may be added that the oil barrel had a locked faucet, so that unwarranted use of oil was prevented. To render the comparison with electric lighting more easy, we may reduce this figure to monthly consumption, and obtain $9.70 as the monthly lighting bill. Not all of the 13 lamps were lighted on every night, but they may be counted as being in regular use. Now, what could be done under similar conditions with the incandescent lamp? On a liberal estimate, wiring the house for 15 lights would have given an illumination at least equivalent to that obtained by oil. It then appears that incandescent lamps at 64 cents per month would have been actually as cheap as oil, with the additional great advantages of no care, no danger of fire and no pollution of the air. It may be replied, however, that the month taken as the basis of estimate was probably the one requiring most light, so that there would be a saving in oil during other parts of the year so great as to render the fixed charge for electricity anything but economical. This, of course, is in a measure true, but the number of incandescent lamps was deliberately taken larger than was necessary, to allow of fixed lamps in places where oil lamps are occasionally carried; and, further, 64 cents per month is not a specially low rate for incandescent lamps in domestic service. In selling by contract the prices of course vary enormously from place to place. A few figures may however be of interest, particularly as they relate to small plants such as might be found in towns of very moderate size. In one small city the charge for domestic lighting is 60 cents per lamp per month, the number of lights connected being less than a thousand, on the direct current system, coal being the fuel used at the station. Another direct current plant, having only 500 lights and burning coal obtained at a low rate on account of favorable situation, charges only 20 cents per month for domestic service, provided at least six lights are wired. Still another, situated in a location where coal is about as expensive as in New York City, and furnishing 700 lights, charges for regular use 80 cents per month, and for occasional lamps 50 cents per month. As the latter class includes all lamps in sleeping apartments, and other rooms not constantly inhabited, the average price would fall to something like 60 cents per month. In contract price, however, low water mark is probably touched in a certain water power plant where the charges for lamps in regular use average 30 cents a month, and for those in occasional use, such as mentioned above, are furnished at 12½ cents per month.

Where any considerable number of lamps are used, as in large suburban towns, they can be furnished at a good profit at 50 cents a month for domestic service; this, however, does not apply to commercial lighting or other cases where lamps are to be used regularly. But for the service we are discussing the price is such as very many companies would be only too glad to get. So much for lights supplied by contract. It is tolerably evident from what I have previously said that the difference in cost between oil and electricity for equal service may be merely nominal, and not infrequently in favor of electricity.

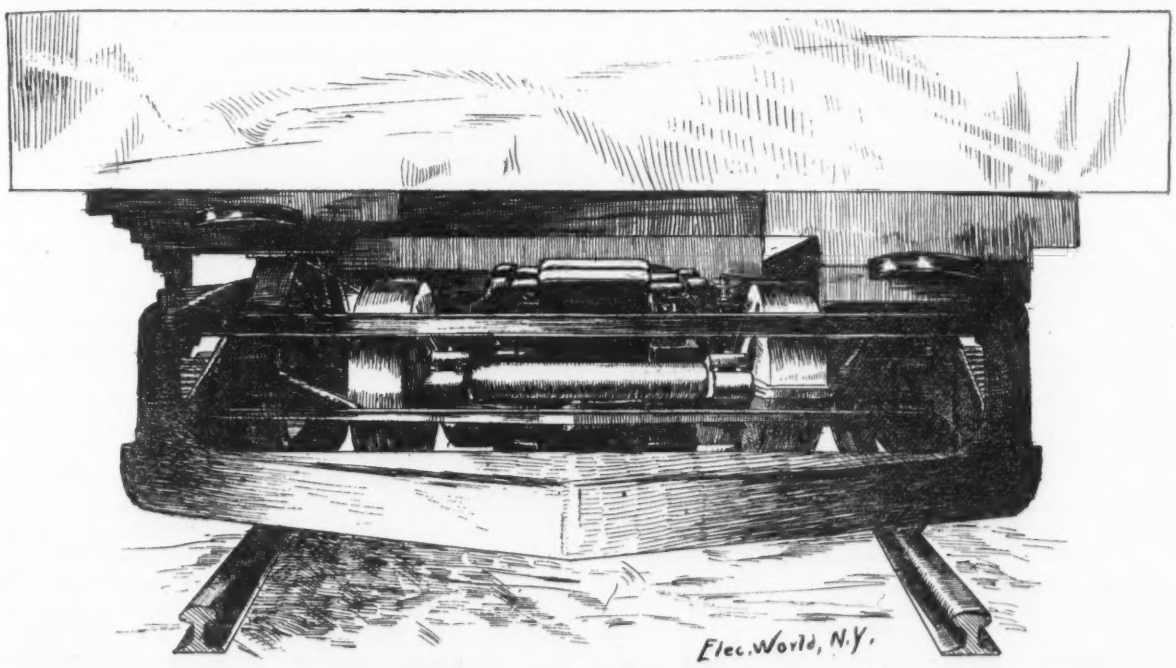
Where incandescent lamps are supplied by meter the case is even more favorable. Assuming the standard central station charge of one cent per lamp hour the house above mentioned could unquestionably have been lighted as cheaply by electricity as by oil, for 32 lamp hours per night would be quite adequate for the service required; and here the comparison would be a fair one throughout the year, as only the electricity used is paid for. Unless in unfavorable situations one cent per lamp hour is a profitable selling price for incandescent lights, and this fact is attested by its being the charge made very frequently by city central stations, and even by small companies doing precisely the kind of work of which we are speaking. As a final contribution to the economy of

this particular case we are considering it should be mentioned that the price for gas in the town spoken of was $2.85 per thousand feet, which makes it distinctly more expensive than electric lighting at the rate last named. It is far from my purpose to contend that everywhere and under all circumstances electricity is the cheapest illuminant, but I hope that I have successfully shown that in many cases it could replace not only gas but oil lamps without increasing, and even in some places diminishing, the cost of illumination. Of course the weak point of the oil lamp, so far as economy is concerned, is the necessity for keeping it burning when the electric light, or even gas, would be extinguished. A lamp is not lighted without inconvenience, and therefore in rooms which will be occasionally visited during an evening oil is being constantly consumed where gas jets or incandescent lamps would be turned off. If one wished to go to the trouble of extinguishing and relighting these lamps a considerable saving might be effected; but for residences where plenty of light is desired and convenience somewhat consulted, the consumption of oil rises to an amount that gives gas and electricity an excellent chance for competition.

To sum up, where incandescent lamps can be obtained at one cent per lamp hour, or an equivalent contract price, they will compete on favorable terms not only with gas, but with oil, supposing equal illumination in each case. Aside from this the greater cleanliness and convenience of the incandescent lamp should commend it even where it is slightly at a disadvantage. It is a great pity that more suburban towns do not take advantage of electricity for house to house lighting, particularly since at the prices mentioned an electric light plant is in most situations a very good investment. This statement should not be understood as applying to localities where coal is very high, or where from an isolated situation or local circumstances the cost of operation rises to an amount considerably above the general average.

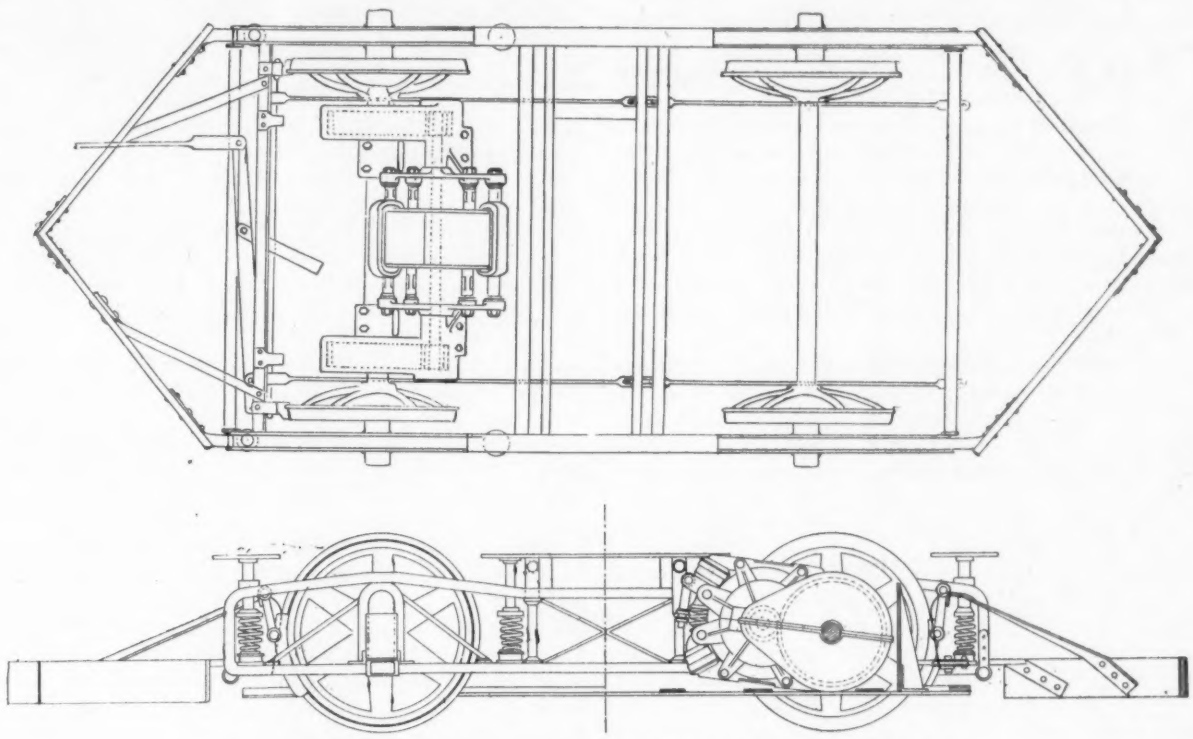
The Baxter Street Railway Motor.

At the present time the advent of a new electric street railway motor is not such a rare event as necessarily to attract any considerable amount of attention. The more novel and effective the machinery displayed, however, the more attention will necessarily be attracted by a new system. It is the appearance of a decided novelty that we are about to chronicle. A few days since the Baxter Electric Motor Company announced that on Dec. 27 an exhibition of its new street car would be given, and extended an invitation to a large number of prominent business men, electricians and representatives of the press from all parts of the country. The new motor had been rumored for some time, and, therefore, there was the greatest expectation on the part of those present. The direction in which the Baxter Company has worked in making this improved motor is to lessen the very objectionable gearing heretofore employed. Of course it would be most desirable to put the motor upon the car axle, but the problem is so difficult a one that as yet no motor so arranged has been exploited in a commercial way. All our present systems, with the exception of the Wenstrom and this new Baxter, employ motors of so high a speed that they must be geared twice by the interposition of an intermediate shaft. The Wenstrom motor has been already described in our columns. Mr. Baxter has devised a very different but decidedly effective solution of the problem of slow speed; he has done this by the obvious means of employing the multipolar machine.



THE BAXTER STREET RAILWAY MOTOR.

The armature in the Baxter street railway motor is 18 inches in diameter, and at each end of the armature shaft are 4½-inch pinions which gear in the 18-inch wheels on the car axle; the speed of the armature, therefore, is four times as great as that of the wheel, so that when the car is running at about eight miles per hour the armature will revolve at something like 335 revolutions per minute. With the cars ordinarily in use the armature speed would be something like 1,000 per minute for the same rate. The motor of course is multipolar, having eight poles formed by four separate magnets, each having its own magnetizing coil placed so that the poles alternate around the armature. The core of the armature and the hub of the motor are insulated with particular care to avoid the short circuits which sometimes occur through grounding on the frame of the motor. The motor is series wound and has the various segments of the armature coils connected in series by a special method devised by Mr. Baxter. The conductors lie in grooves on the exterior of the armature, so that the Pacinotti construction is really the one followed. The brush holders are composed of two side castings, so arranged that the upper can be pulled out of place in an instant with the fingers and the brush removed and replaced again just as quickly. The solidity of construction in the brush holders prevents vibrations of the brushes, and aids them to run without any visible sparking. Both brushes are on the upper side of the commutator in full view. The accompanying illustrations give a good idea of the construction of the motor and its method of application to the truck.



SIDE ELEVATION AND PLAN OF BAXTER MOTOR TRUCK.

The gears are inclosed in an oil-tight chamber so that they are perfectly lubricated and protected from dust and grit which would tend to wear them loose. In this way the little noise that is produced is much muffled and the car runs very quietly and easily. All bearings are dust tight, and are self-oiling. The motors are suspended something after the usual method, but the suspension rod is some six or seven inches long and prevents the motor from slipping up and down, although it does not restrain lateral motion; therefore, if the car or truck should sway even an inch or two no strain will be brought upon the motors or gearing. In addition to this the end of the motor next to the suspension moves with the car, and there is, therefore, little vibration at this point where the circuit wires are connected from the motor to the switches, so that there is very little liability of their getting out of order. In addition a dust-tight casing is presented to cover over the entire machine.

The governing is by rheostat, and the car is operated by a single crank shaft. Turning it in one direction the car moves forward, in the other direction reverses, and the speed of the car is controlled by the distance through which the crank is turned. In addition to securing slow speed by the multipolar construction a light weight efficiency is also obtained, so that the two motors, each of 20 nominal horse power, weigh together but 3,000 pounds. This is considerably lighter than the usual street car motors, which weigh from 2,000 to 2,500 pounds apiece. The rheostat and regulating apparatus are placed between the motors under the car floor, and therefore they can be easily reached by opening the trap doors. The lightning arresters are placed in the same situation and are in series with the rheostat, which serves as a choking coil to afford additional protection.

The trial trip in the yard of the factory was a complete success. At about two o'clock in the afternoon the visitors, in number over 250, under the guidance of the officers of the Baxter Company, left Baltimore by special trains, and on arriving at the works were served with an elegant luncheon, in which terrapin and other delicacies which Baltimore knows so well how to furnish were a prominent part. Then in groups of twenty to fifty the visitors took turns in riding around the track on the improvised flat car used for this occasion. The track was one-eighth of a mile in length, having a three per cent. grade for a quarter of its length, and curves of 35 feet radius. In spite of the fact that the track was covered with snow and the wheels tended to slip upon it the motors ran smoothly and quietly and rapidly, reaching a speed over ten miles per hour even on the difficult track used. Too much praise cannot be given the company for the courtesy and care with which they looked after every want of the guests, and the admirable way in which everything had been arranged for the test. Little more could be desired in the way of success in the preliminary test on a difficult track, and the new motor gives promise of doing admirable service in practice.

Among the guests were Mayor Davidson, Ex-Mayor Latrobe, Ex-Mayor Hodges, General Bradley Johnson, Ex-Governor Wm. Pickney White, Ex-Governor Bowie, Nelson Perin, president of the Baltimore Union Passenger and the York Turnpike Street Railway companies; Frank Ridlon, of Boston; Professor Charles Hasson, of Johns Hopkins University; Mr. H. H. Harding, of Chicago; Robert Watson, of Brooklyn; Oden Bowie, president Baltimore City Passenger Railway Company; Robert Rennert and Fred De Land, representing THE ELECTRICAL WORLD, New York. The officials of the Baxter company who were present were E. C. Hight, president; R. B. Griffin, secretary and treasurer; David E. Evans, superintendent; J. L. Blackwell and W. R. Mollinard, general agents, and William Baxter, Jr., the successful inventor, who was the recipient of many congratulations on the successful operation of his new motor.

Variations of Conductivity Under Different Electrical Influences.

In a paper on this subject read recently before the Académie des Science, M. Ed. Branly stated that if a circuit be formed with a Daniell's cell, a high resistance galvanometer, and a very thin layer of copper deposited on a ground glass or ebonite plate, seven centimetres long and two centimetres wide, only an insignificant current passes. An abrupt diminution of resistance is experienced, however, when electric discharges from a Wimhurst machine or a Ruhmkorff's coil are produced in the neighborhood of the circuit. The action diminishes as the distance of the sparking apparatus increases, but it may be very easily observed, without special precautions, at several meters.

The Largest Arc Lighting Station in the World.

The report of the general manager of the Municipal Electric Lighting and Power Company of St. Louis for the month of September shows an income from the city lighting of some $10,000 and an allowance or rebate for imperfect lighting of about $80, a deduction of less than one per cent.; and this, too, in the face of a system of checks and counter-checks that appears to render it impossible for a lamp to blink twice in succession without having a report entered against it. Furthermore, the plant has not yet been in operation seven months, though during that period not a moment's time has been lost, except on one occasion, when the carelessness of an employé caused the shutting down of two engines for something less than 30 minutes.

Brought into existence under adverse circumstances, and with new conditions to be met on every side, planned and completed in the face of difficulties that appeared almost insurmountable, and within a period of time almost too short for belief, the central station plant of the Municipal Electric Lighting and Power Company, of St. Louis, stands to-day a splendid monument to the ability, foresight and indomitable will of the man whose keen, practical judgment and guidance has placed in successful operation the largest arc lighting station in the world, Mr. James I. Ayer.

The operation and maintenance of this plant is so simple and economical that many of the features introduced are worthy of careful consideration by all central station men, while every reader can find much of interest in the businesslike methods pursued in the management of this great enterprise that includes, in addition to the substantial station, a pole line circuit nearly 900 miles in length, supported on some 10,000 poles.

When the City Assembly, on Dec. 29, 1888, gave ten days' notice to the St. Louis Board of Improvements in which to advertise for 30 days in newspapers of St. Louis, New York, Philadelphia and Pittsburgh for proposals to light the city streets and public buildings with electricity, and to prepare all necessary plans and specifications for the work, it was considered simply a political move in the results of which the people had so little faith that on the day the contracts were awarded, March 9, 1889, a wager of $1,000 was offered that they would never be closed.

Mr. Chas. Sutter received the contracts for the out-door lighting of both Northern and Southern districts of the city by the arc system, Washington avenue being the dividing line between the districts. His bid for the Southern district was $84,780.50, and for the Northern district $81,659 per year.

One incandescent lighting contract, for illuminating public buildings and alleys in the Southern district, went to the Missouri Electric Light and Power Company at $50.525 per year; and the other incandescent lighting contract, for the Northern district, went to Charles E. Brown, of the Western Electric Company of Chicago, at $33,327.80. The latter assigned his contract, almost immediately, to the Laclede Gas Company, which is carrying it out.

The original specifications called for the following lights: For lighting the streets of the Southern district, comprising the territory between Keokuk street and Washington avenue, 1,100 arc lamps of 2,000 c. p.; 20 arc lamps of 2,000 c. p. for the parks; 30 arc lamps of the same power for public buildings; for parks in addition 200 incandescent lamps of 30 c. p.; for public buildings 2,200 incandescent lamps of 16 c. p. For the Northern district, 1,000 arc lamps of 2,000 c. p. each for street lighting; 10 arc lamps of 2,000 c. p. each for the parks; 50 arc lamps of the same power for public buildings; 100 incandescent lamps of 30 c. p. for the parks, and 890 incandescent lamps of 16 c. p. for public buildings. The magnitude of the arc light contract and of the whole undertaking can be more easily appreciated when it is further stated that not one stroke of work had been done toward carrying the contract to completion when it was awarded, though but nine months remained in which to complete the work.

Mr. Sutter's first move was to secure the services of a competent superintendent, and in appointing Mr. James I. Ayer to that position, on June 21, the successful termination of his important plans was practically assured. Mr. Ayer at once notified the various supply houses of his requirements, and the visits of wire, pole, engine, belting and general supply men to the Southern Hotel, in May, 1889, will long be remembered by the representatives present. Meanwhile, a piece of ground had been secured extending west along the railway tracks between Eighteenth and Twenty-first streets and the Missouri Pacific tracks. It was an admirable location, but of less size than desired, though all that could be obtained in that vicinity, and was what remained of an old stone quarry, having a high bank at one end that had to be blasted down and a deep excavation at the other end that required filling, all of which consumed valuable time. Then the necessary foundation over the filled ground portion was secured by driving 800 piles in regular rows through 20 feet of the made ground to the solid rock, placing on top a cap of 12 × 12 timbers and filling the space between with a layer of macadam concrete, and covering all to a depth of six inches above the capping. On this concrete the brickwork was laid in cement, 1,200,000 brick being used for the foundations of the engines alone. All this work was necessary, as more desirable ground could not be secured for a reasonable investment, and on this site the buildings stand completed to-day, and consist of the station proper, the annex and the boiler house; all substantial, fireproof structures of pressed brick, stone and iron.

The boiler house, having a frontage of 110 feet, a depth of 60 feet, and an interior height of 48 feet, stands 50 feet distant from, but connected to, the station house by a viaduct supported on steel I beams with concrete arches covered with granitoid cement, the top or surface of this viaduct forming the end of Nineteenth street. The available floor space within the boiler room being but 54 × 104 feet, and as no additional ground adjoining could be secured for any price within reason, the prominent boiler makers of the country were called in to estimate on the greatest amount of boiler capacity that could be placed therein. Finally the management gave the contract to the firm of Rohan Bros., of St. Louis, stipulating for the installation of 19 of the Phil. Rohan special type of upright boilers with a total minimum indicated horse power capacity of 6,500, and these boilers, or so many as are now requisite, are in daily operation. The coal used costs $1.50 per ton delivered on the track close to the boiler house and is shoveled into small hand cars that are then pushed along a tramway till the coal is dumped into a runway that leads directly in front of the furnace door, thus necessitating the handling of the fuel but once before being placed in the furnace. Six of the boilers have been equipped with the Standard Oil Company's fuel oil device, and the necessary oil is delivered in tanks at a cost of less than two cents per gallon. The use of fuel oil has increased the rated capacity of the boilers about 20 per cent., and it is considered a most desirable fuel in every way provided the price was made sufficiently low to compete with the low price at which coal can be purchased.

Rohan's special exhaust steam heaters and purifiers and Hall's duplex pumps are in use; these with the oil pumps and filters and the steam supply and exhaust pipes are on the lower floor of the annex connecting the boiler house to the station and commonly referred to as the viaduct, the upper floor of the annex, which is about four feet above the level of the railway tracks, being used for the receiving and storing of coal, freight, etc.

The smoke stack is of quarter-inch boiler iron double riveted, 226 feet in height and 13 feet in diameter, the base, 32 feet in diameter, resting on a solid foundation of seven feet of concrete placed on solid rock 27 feet below the level of the railway tracks. This iron stack is said to be one of the largest in the country, and the coronet of arc lights suspended from the gallery near the top is the admiration of every lover of the beautiful, and can be distinguished for many miles when burning at night.

All steam pipes, valves, fittings, etc., leading from boilers to engines are in duplicate throughout. There are no overhead steam pipes within the station house, the pipes passing beneath the flooring. There are three main steam pipes of wrought iron, hot riveted, with expansion joints, that are carried in hangers supported on the I beams of the engine room floor. The largest is 24 inches in diameter, the second 18 inches and the third 10 inches: the first two being 170 feet in length. The third, or smaller pipe, is an auxiliary feeder for daylight service, and is independently connected to three engines, thus enabling the company to operate up to a thousand arc lights without putting a pound of steam in the main pipes. The exhaust main is 36 inches in diameter and suspended under the feed pipes. All the steam pipes are properly covered with Flegle's patent air space covering consisting of a metallic wrapper having flanged contact edges holding the insides of the wrapper distant one-half inch from the pipes and forming an air space of 28 inches in length; each end being sealed with asbestos fireproof cement. The covering inclosing the metal forming the air space is of sheet asbestos and paper placed in layers to the depth of half an inch, the outer coating being finished in canvas and painted white, rendering it waterproof as well as a perfect insulator. The boilers and larger surfaces are surrounded with Flegle's metallic air space covering, over which is placed a one-inch layer of asbestos cement, rendering it fireproof in every respect. As the atmosphere of the pipe tunnel is always from 30 to 60 degrees Fahrenheit above that of the engine room, excessive condensation is well guarded against. The object obtained in carrying the pipes beneath the flooring is that all overhead hangers and scaffolding is done away with; the vibration to the pipes is lessened as the ends of the I beams are embedded in the engine foundations; all dirt and drippings from leaks that prove so annoying in an engine room are avoided; all possible damage to belting from the escaping of steam is obviated, a matter of much importance when so large a number of cemented belts are in use; the convenience in making repairs is increased and the general appearance of the engine room enhanced by the absence of overhead piping. All condensation of steam in the pipes is trapped back to a hot well from which it is pumped to a tank on the roof and from there returned to the boilers, effecting a saving of about 50 per cent. in water consumption.

The station house proper is a handsome four-story, fireproof, pressed brick and stone building, with a depth of 100 feet, a height of 65 feet and a total frontage of 110 feet. The stone base is well carved and seven pilasters enrich the appearance of the front, while the windows and doors are arched. The walls range from 26 to 18 inches in thickness, the floor beams are of rolled steel, the stairways entirely of iron, while the total cost of station, annex and boiler house aggregates $200,000.

The lower or ground floor contains the engines, the second floor the line shafting and friction clutch pulleys, the third floor the dynamos and switchboard and the fourth or top floor the store room, testing department, general repair shop, bath rooms, closets, reading rooms, library, etc., while the wire or line circuit house is on the roof. These floors are supported by round cast iron columns placed in rows about 18 feet apart, those on the main floor being 12 inches in diameter, diminishing to eight inches on the top floor.

The engine room is on the ground floor, a step above the level of the railway tracks, and is 105 feet long by 95 feet deep by 20 feet in height, with a granitoid flooring. This room is arranged to contain ten engines of the Hamilton-Corliss type, each of 600 h. p., six being now in position, and the remaining four will be added as fast as required. To each engine is assigned a load of 840 arc lights divided into a dynamo capacity of 14 sixty light dynamos, or the equivalent of this duty in power or incandescent work. Thus the total capacity of the station will be 8,400 arc lights or, allowing a reserve force of one-sixth, a standard working capacity of 7,000 arc lights, a greater working capacity than any plant now in existence.

Underneath the engine room is a large oil cellar in which the oils used are filtered upwards through water, sand and charcoal. Galvanized iron lined oil cabinets stand on every floor and contain the oiling cans and the wiping towels, no "waste" being allowed about the place. Cleanliness is preserved in the highest degree.

The second floor is equipped with 400 feet of 6-inch hammered iron shafting, ground and polished, divided into eight sections of 50 feet each and set up in four parallel lines on floor stands which are bolted to double I inch beams below. The bearings of the shafting are self-aligning and adjusting and vary in length from 18 to 32 inches. Each shaft is driven by a 48-inch double leather belt running over a steel rimmed pulley 56 inches in diameter, 52-inch face. On each shaft is placed seven doubled crown friction clutch pulleys 52 inches in diameter, with 22-inch face, from which lead fourteen 10-inch belts to the floor above to drive the dynamos. Both the 112 small belts and the large 48-inch belts were furnished by the Charles Munson Belting Company of Chicago; Charles A. Schieren & Co., of New York, and the Shultz Belting Company, of St. Louis. The clutch mechanism is operated from the dynamo floor by a simple lever device which lies in a cavity in the floor made to receive it when not in use. Each engine belt has a patented steel rim tightener pulley 36 inches in diameter with a 52-inch face, which is operated from the shafting floor to tighten or loosen the belt. All the castings are exceptionally smooth and well made, all collars and couplings being well turned and polished, giving the whole a finished appearance. The boxes are lined with babbitt metal, reamed and bored, with deep oil grooves running backward and forward that insure perfect lubrication. The necessary oil is fed to each bearing by a system of pipes and carried thence by drain pipes to the oil filter in the basement, from which it is pumped to the fourth story to be used again. All the transmitting machinery on this floor was made and set up in place in a most thorough and workmanlike manner by the Falls Rivet and Machine Company, of Cuyahoga Falls, O., and the best evidence of its satisfactory character is that, while only one man is required to care for all of it during operating hours, not one minute's time has been lost from any mechanical defect or cause since the plant was started.

The dynamo room is on the third floor, and extends the full length and width of the building. Fifty-three 60-light improved Wood dynamos, manufactured by the Fort Wayne Electric Company, occupy a little less than half of the available space for dynamos. The conductors from the dynamos are carried through the floor in glass tubes to a series of racks suspended underneath the floor of the dynamo room and above the transmitting machinery, wherein they are supported on glass tubes till passed upward through the floor in a casing of glass and terminate in a table immediately in front of the switchboard, where they are connected to duplex sockets. The switchboard is a model of its kind, designed from plans made by Mr. McGrath, of the Fort Wayne Electric Company, and modified or added to, to render it more complete. The switchboard proper is furnished with duplex terminals to all circuits in each of seven different sections, and is so arranged that within a space of about seven feet square, which constitutes a section, connections can be made with any other circuit. The top of the switchboard is surmounted with a cornice which contains 70 current indicators made by the Lockwood Instrument Company of Detroit, and so arranged as to indicate when the current is flowing through a circuit and in what direction. In one section, at one end of the switchboard, ammeter sockets are being placed in a position that will enable the dynamo tender to rapidly plug an ammeter in any circuit.

Owing to the systematic methods employed, the entire lighting of the city is started practically on the instant, it requiring never more than 120 seconds to have every lamp burning. This rapidity of lighting is greatly facilitated by the perfect working of Mr. Wood's automatic regulator. Steam is turned on about 15 minutes earlier, and thus an

important saving is effected for the burning of 3,000 or more lamps for half an hour too long or not long enough means an output of fuel the value of which in the aggregate amounts to a large sum, or to a heavy rebate.

Since the machinery was placed in operation, Mr. Ayer has been regularly operating 62 lights over a circuit of 19½ miles and the brilliancy of the lights and the normal ampère current maintained. This speaks well for the line insulation and connections as well as for the dynamos.

On the dynamo floor is located the fire alarm gong, directly connected to the headquarters of the City Fire Alarm Department, and a private telephone connected with the Police and Fire Department. Thus every alarm is repeated in the dynamo room, and on a second alarm being turned in an inspector hurries to the relief of the firemen. On this floor, where all the trimmers and line men have easy access, is placed an immense map of the city, all lamps being indicated by tacks, and the various circuits by different colored threads. By this means any circuit can be readily traced and every lamp located. Station managers who have been compelled to keep unsatisfactory employés simply because they were acquainted with the circuits and the location of the lamps will appreciate the value of such a map. There is a small office on this floor and a public telephone, also a private telephone connected to the down town offices.

On the fourth or top floor, where the wires come in from the wire house on the roof and pass to a rack holding the Thomson-Houston lightning arresters in parallel rows, is placed a testing board arranged for connections with Wheatstone bridge, ammeters and voltmeters to all circuits. The station is supplied with Weston's direct reading voltmeters, reading from one-tenth of a volt to 150 volts, with multipliers for same, giving a reading to 4,500 volts: Weston's and Wood's ammeters, and Greeley's high grade galvanometers are also at hand. All circuits are tested at regular intervals four times each day, and the voltage is daily measured across the terminals of each circuit, a record of each test being entered on the proper blank, headed, "Record of circuit tests for the 24 hours ending ....," which blank also shows the length of each circuit, and the number of lamps in that circuit. Thus the highest efficiency is obtained, as any increase in the normal resistance is at once indicated; the leakage to ground being also measured while the circuits are in operation and the location of the leak detected. Each and every circuit is connected with the ammeters several times during the night, so that any change in the quantity of current is detected and remedied at once.

The Repair Department is also on this floor and contains lathes and other machinery, the necessary tools and competent workmen. Thus, if a lamp needs overhauling it is brought in and a card bearing the following heading is attached, and there remains until the lamp is again placed in service: "Record of lamp repairs—Lamp No. ..... returned ....., 1890, by ....., from ....., trouble ..... Material used ....., $..... Hours labor ..... $..... Testing.... $.... Total $ ... Lamp run ... hours...., 1890; volts ....; volts : volts ....: lamp run ..... hours ..... 1890; volts .....; volts ....: volts ....; ready for service ....., 1890. Entered L. R. by ..... Entered daily R. by ..... When all mechanical repairs have been made on a lamp it is given a twelve hour run on the test rack, and the length of the arc determined by the use of the voltmeter only, two standard Weston ammeters being used constantly to insure a normal ampère current at all times during the test.

In caring for the lamps 40 trimmers are employed, each being furnished with a two-wheeled cart and the necessary harness; but each trimmer furnishes, feeds and shoes his own horse. A blacksmith shop is maintained by the company and there the trimmer can have his horse shod at an expense of $1, if he so desires, the usual rate being $1.50. The 28 trimmers employed on the city circuits are under the direction of the chief inspector, as are also the five deputy inspectors and the two lamp changers. Each of the city trimmers are now daily cleaning 63 lamps on a 15-mile circuit and a 20-mile drive, and are gradually working up to an average of 70 lamps. Before starting on his round each trimmer is supplied with the required number of carbons, with one globe and the necessary clean towels, and on completion of his day's work he fills in a blank form reading as follows: "Trimmer's daily report"—Trimmer....., District No ....., ..., 1890. Number of lamps ....., S....., D .....; total..... Number of carbons received, 12 inch ....., 7 inch..... ; number of carbons used, 12 inch ....., 7 inch.....; number of carbons in box, 12 inch....., 7 inch..... Globes replaced: Clear....., one-half ground .... , opal..... Lamp towels received ....., returned....., in box ..... (State condition of lines, lamps, poles, etc., in your district, and changes or repairs made by you this day.)

It is not only necessary for the trimmer to make out this daily report, but he must return a carbon point for every new carbon issued and return a soiled towel before a clean one is given, all shortages being charged to the trimmer and deducted from his pay. Towels free from lint are used on all the globes and "waste" is not tolerated about the building. (In this connection it is worthy of note that the ends of all plain carbons are returned to the factory, where they are ground up and made over again; and all carbon boxes are sold to local wholesale hardware dealers at 10 cents each.) That the above method is satisfactory to the trimmers as well as to the company is clearly shown by the industrious manner in which they perform their duties, the excellent class of men secured and the large number of applicants for these positions. Then to encourage the men to improve on their work as shown in their daily record, and in that of the inspector, a comparative monthly record is kept that shows at a glance whether the man's service is improving or not, and on the fifth of each month a letter is sent to each trimmer commending him for noted improvement or mildly checking for apparent neglect. That these letters prove beneficial may be easily seen from the records which show that during the first month 185 globes were reported broken out of a total of 1,650 lamps; the number of lamps have been steadily increasing while the total number of globes reported broken each month has decreased respectively 185, 104, 57, 45 and so on down till the breakage to-day is less than 2 per cent., an excellent condition that has been brought about entirely by careful systematic checking. The advantages secured in using the cart in place of putting the man on horseback are manifold and obvious. A long rubber coat covering the trimmer from head to heels is furnished by the company and carried in a special compartment of the cart. Covered with this coat in rainy weather the trimmer drives along, standing on the foot-board of his cart protected from moisture in every way; the carbons are kept dry and there is always an abundance of dry towels with which to clean globes. Quite naturally the man feels that he is being well taken care of, and puts forth his best effort in the interest of the company.

One of the general accounts is headed, "Lamps and Trimmers," and is made up from the details entered on the lamp maintenance monthly sheet, which bears the following headings for entries opposite each day of the month: Date; number of men; cost of labor; single lamps; lamps repaired; number; cost; one-half carbons; seven-sixteenths carbons; total carbons; clear globes; one-half ground globes; cost of globes; opal globes; cost; cost of towels; stable expense; total cost of lamp maintenance. That sheet is prepared from the "Daily Report of Trimmers" (form 23), which reads: Trimmer (Nos. 1 to 60) total number of lamps; lamps trimmed; single; double; number of carbons used; one-half inch; seven-sixteenths inch; number of globes replaced; clear; one-half ground; opal; towels; labor time; cost; remarks.

The chief inspector has charge of the day inspector, the four night inspectors, the two lamp changers and the twenty-eight trimmers, employed on the city circuits. Special two-wheeled carts are furnished to each, the inspectors having strongly built but light carts made especially for rapid traveling and having a compartment under the seat sufficiently large to contain 150 feet of line wire, a cut-out or two, insulators, brackets, pliers, and whatever is necessary to rapidly construct a loop line. Each inspector furnishes an excellent horse that can be depended on, and when a telephone message comes in that a heavy wind has blown a tree across the lines, or a second alarm is received from the fire department, the inspector drives with the utmost haste to the point of trouble, and takes such action as may appear necessary to keep as many as possible of the lights burning or to repair the line. During a recent fire prompt action on the part of an inspector prevented a loss of $145 in rebates that would have been deducted had not his work kept every lamp in circuit. This method of looking after troubles at night is so systematized that only in two instances has a circuit remained open for over thirty minutes; a rare and remarkable record.

The "Inspectors' Daily Report" reads: From ..... P. M. to..... A. M....., 1890. Description of trouble.....; material used....., $..... Reported troubles by telephone at ..... P. M., ...P. M., ...P. M , ...A. M., ... A. M., ...A. M. Total hours locating trouble ..... Total hours removing trouble..... Total hours on patrol ..... Total hours at station..... Number of troubles found by me..... Number of troubles reported to me ..... Number of troubles cleared.....

While form 6 reads: This certifies that my lights were inspected at .....P. M., also at .....A. M., and the service has been satisfactory since last report, except as noted below.....

These reports and that of the chief inspector are incorporated into a "Daily Report of Inspectors" (form 39), reading as follows: Number, on duty, from ..... to .....; number hours.....; hours patrol ..... ; hours on trouble ..... ; number troubles..... ; found by him..... ; reported to him. .... ; total .. .. total removed..... ; total fire calls..... ; cost..... ; repair ..... ; material ..... ; stable..... ; H., C. & H.....; amount..... rate ..... ; wages ..... ; remarks.....

The conditions under which this work was planned and carried through were so different from those usually presented that new methods and new forms of material had to be created. For instance, guy wire would not be tolerated on the main streets, so a simple, inexpensive form of truss was devised for maintaining the poles at street intersections as shown in the illustration, which also shows the method of suspending the lamps. As all arc lamps had to be suspended 35 feet above the roadway clear of the bottom of the lamp, and not more than 800 feet apart, the Board of Public Improvements in the contract specified "that lamps shall be suspended over centre of street," and in compliance the simplest device known, consisting of ⅝-inch steel suspension cable attached by means of eye bolts to poles of proper height was selected. To this cable two Fletcher sleet proof pulleys were firmly attached, one being placed in the centre and the other close to the pole supporting the windlass box.

These windlass boxes are made so as to be used on either side of the pole and always permit the drum to rotate inwardly or toward the pole, thus drawing the raising cable, which is one-quarter inch charcoal iron wire of 32 strands, close to the pole. Each windlass door is fitted with a Yale lock, so that when the lamp is once left in position it cannot be disturbed without cutting the wire rope, and to do that it will be necessary to climb the pole, as the boxes are placed about six feet above the sidewalk.

All the lamps are of the Wood type of double carbon lamp and are protected by a deep conical hood complete with hanger board and cut-out. The cross support for wires over lamp hood is provided with double petticoat pony glass insulators.

In constructing the circuits and the entire plant they were built for the future, anticipating the rapid increase that has already set in. At the present time there are 176 wires or 88 round circuits that pass out or return to the building through glass tubes and hollow fire-brick. These wires pass out from the wire house on the roof of the station, and thence to the first pole in regular order, commencing at the top cross arm, so that a lineman, being told the number of a circuit, can easily trace or pick it up at any designated point. Simplex wire has been used throughout the entire installation, over 900 miles being now employed. At the time the contract was placed for wire Mr. Ayer was besieged by the representatives of the different manufacturers of insulated wire, and strong pressure was brought to bear to induce him to purchase a low priced insulation by representations to Mr. Sutter that "the cheapest was just as good." But Mr. Ayer took a firm stand at a time when high grade insulation for aerial wires was little used. Within a few months he had the satisfaction of seeing his position supported by newspaper argument, and, what is more convincing, large orders for similar insulation were placed by parties well advised who were constructing other large plants and who had previously criticised his action.

Over 10,000 select white cedar poles have been used, ranging in length from 40 to 65 feet, the majority of which were "gained" for five cross arms, and all were neatly shaved. The cross arms used are four, six and eight pin, and are 5, 7 and 9 feet in length respectively, thus allowing ample room for a lineman to work between the wires, and every cross arm has been braced.

Among the special circuit devices is a cross circuit break arm having a total spread of 15 inches, 10 inches from one pin to centre of core, leaving only 5 inches from the remaining pin, and which are used where it has been necessary to cross from one end of the arm to the opposite end and safely clear all other wires and the pole and not interfere with the climber.

The wall brackets used have a strong base, allowing fully two and a half inches between the screw holes; the sign and roof bracket is eight inches in length, with an oval base having four screw holes. Then there are lateral, right and left hand, cornice, side and off-set brackets. All these are made of the best quality soft gray iron, cast in star shape form, and are exceedingly light but of ample strength, and of improved form. When stringing the wire one man in each gang was employed solely in making and soldering all joints, and was previously thoroughly instructed in the art preservative of current; thus there is every reason to believe that that portion of the work was well done throughout. Three mottoes were always kept before the men: "When you require insulation you cannot get it too good." "When connections are being made you cannot make them too strong." "Avoid complications; the simplest is generally the most efficient."

Mr. Ayer's systematic method of keeping track of all the minute details that enter into the operation and maintenance of a plant of this magnitude is worthy of more than a passing notice, for there are many features that could well be tested in some of the smaller plants that have proved hardly self-sustaining simply through an absence of all watchfulness over the minutiæ, from the lack of which spring the small leaks that increase in volume so rapidly. Blank forms of about the size and color of a telegraph blank are used, on which the men record the work they have done each day with all details thereto pertaining. From these sub-reports there is prepared in the main office a "condensed daily report" covering the twenty-four hours, that clearly shows in dollars and cents the daily out-put and the daily earnings, as follows: Dynamo room, engine and boiler, lamps and trimmers, line work, inspection, store room, office, salaries, taxes and insurance, stable; total cost. Earnings: City, commercial, extra service, motor earnings, sundry earnings, stable; total amounts.

These sub-forms are also used in daily filling in the condensed monthly report, that shows at a glance both the hours of service and the amount and money value of all material consumed. For instance, under the account heading of "engine-room" the following sub-heads appear: Date, engines in service, hours in service, employés, wages, towels, gallons oils, engine, cylinder, grease, packing, sundry supplies; repairs, labor, material; construction, labor, material.

"Engine-room" and "boiler-house" appear on one sheet, 16

× 20, properly ruled, and by turning back to these various sheets the operating expenses of any day or any month, for any department, or for the entire plant, can easily be traced.

In keeping the general accounts the disbursements are charged under one of the ten headings, as follows: Engine and boiler, dynamo room, lamps and trimmers, line work, inspection, store room, office, salaries, taxes and insurance, while the earnings appear under the headings: City, commercial, extra service, motor earnings, sundry earnings, stable.

A recent feature of the commercial service is the placing of arc lights along Broadway at a distance apart of but forty feet, and suspending same from iron supports projecting from the front of buildings. The price paid for these lights is one cent per front foot per night. Thus they cost a merchant from 20 cents to 40 cents per lamp per night, depending on the width of his store, and their introduction has resulted in increasing the number of pedestrians on Broadway many fold, to the financial benefit of the merchants.

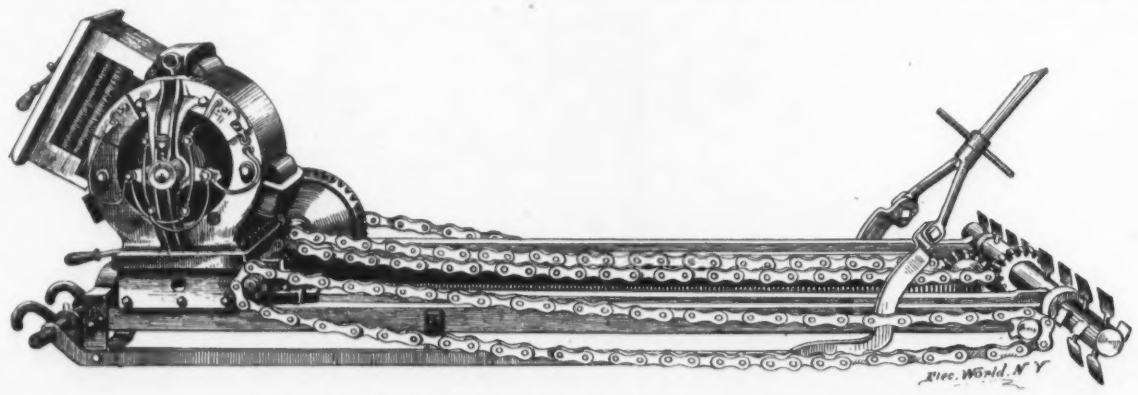
Aug. 1, 1890, by purchase this company acquired possession of the St. Louis Illuminating Company, which comprised the Thomson-Houston plant in St. Louis and East St. Louis, the Excelsior, the Western Electric and the Brush plants in St. Louis, all of which had a combined capacity of 1,500 arc lights; also the Heisler incandescent lighting plant with its 5,000 thirty candle power lamps. Since that date the Thomson-Houston plant and the Brush have been transferred to the new station and the old stations closed, and as soon as a sufficient number of Wood dynamos are received to carry the increased load the other stations will be abandoned, thus concentrating all the arc lighting under one roof, and before Jan. 1, 1891, more than 3,500 arc lights will be controlled from this one station.

The work of dismantling these old stations and disposing of the material to the best advantage was no light task in itself. Then, in addition, Mr. Ayer replaced all the old circuits with Simplex wire strung on new poles, and forming part of his extensive but simple system. As all this old wire is in the usual condition presented by wire strung in past years when competing companies were struggling for business; little else can be done with it than to saturate the insulation in Simplex paint, and cut into small lengths for tie wire, or use short lengths for temporary work. Since Aug. 1, 600 additional lights have been ordered by the city officials, requiring a construction force of about 160 men.

The original officers of the company were Julius Walsh, president; Charles Sutter, vice-president; Mortimer Taylor, secretary and treasurer; James I. Ayer, general manager. The present officers are: James Campbell, president; J. G. Kelley, secretary and treasurer; James I. Ayer, general manager. Mr. Ayer has the following chief of departments: George Clifford, chief engineer; P. I. Parker, chief of dynamo department; C. W. Heeg, chief of line department; J. D. Culls, chief inspector.

The Perret-Stine-Smith Electric Coal Mining Machines.

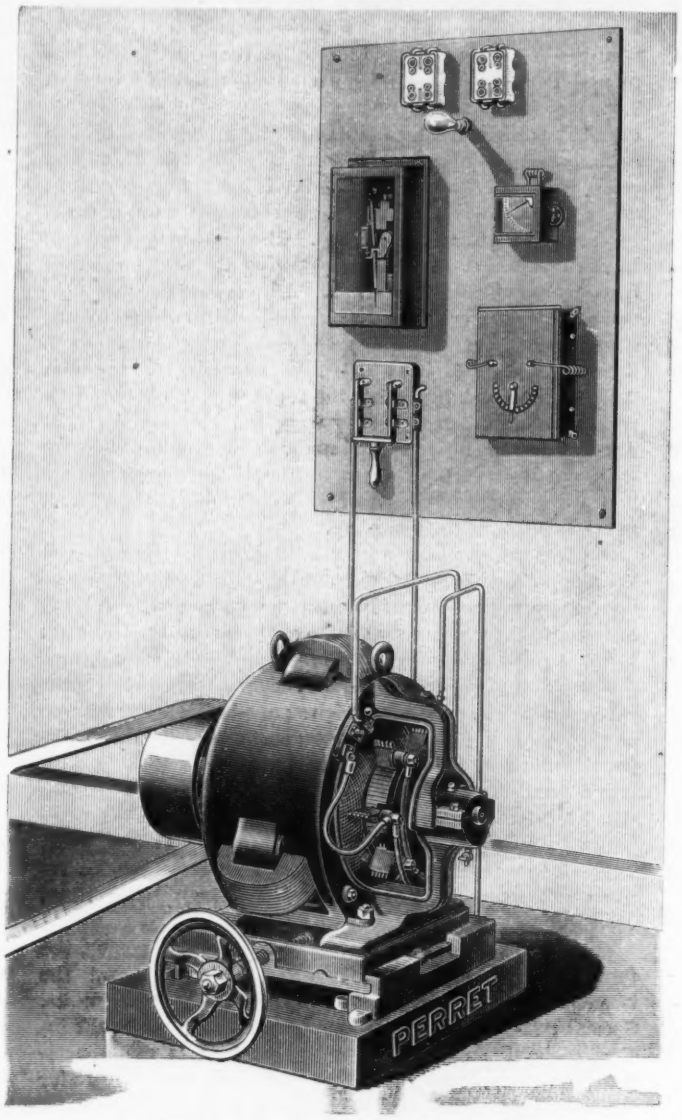
Among recent combinations of electric motors with machinery which had been previously operated by other power, that shown in the illustration is one of the most interesting. It consists of one of the Perret slow speed motors of the multipolar form manufactured by the Elektron Manufacturing Company, of Brooklyn, combined with the Stine-Smith coal mining machines, and is designed to undercut soft coal in the mines. Such work has been done by compressed air, but the Perret motors, which are not only light in weight but low in speed, enable it to be done by electricity in a much more satisfactory manner. The motor shown is of nominal 15 h. p. It is compound wound, so that it has great starting power, and is able to carry a considerable overload for short periods without damage. The speed at full load is about 550 revolutions, which allows it to be connected readily by gearing with the cutting apparatus. The diameter of the armature is 14 inches.



PERRET MOTOR OPERATING A COAL MINING MACHINE.

The apparatus is in successful operation in coal mines near Osceola Mills, Pa., and at hat Cheer, Iowa. The motors are wound for a constant potential of 220 volts. The starting switch is placed upon and made a part of the motor, as shown, so that the whole machine is self-contained, the connection being made to the line by heavy flexible cable. In the Iowa mine mentioned the work has been done under every possible disadvantage, the coal being so hard and so mixed with sulphur in places that 25 to 30 h. p. is scarcely sufficient to cut it, and in certain instances the motors have run up to this point without damage to the armatures. On Pennsylvania coal the power required is much less, seldom running over 10 h. p. at the average rate of working. The machines will undercut the coal for a distance of five feet and three feet wide in five minutes on the average. The motors are equipped with carbon brushes, and the arrangements are such as to require the least possible attention at all points. Motors of similar construction are used for pumping in the mines and also for operating the ventilating apparatus.

The coming year will probably extend very considerably the application of the electric motor to the operation of mining machinery. Its very decided advantages when the source of power is from one to several miles away have already led to its use in a large number of mines, and in every instance its operation has been entirely satisfactory.



A FIFTY-LIGHT MULTIPOLAR DYNAMO.

A Multipolar Dynamo.

The illustration on this page shows a 50-light dynamo recently installed at 26 Vesey street, this city, by the Elektron Manufacturing Company. It is one of a number of the same company's local installations. The machine, as will be seen from the cut, is of the slow-speed multipolar type, recently described in The Electrical World. It is compound wound, regulating automatically so as to maintain a constant electromotive force, with the variation of only one volt. The bearings are self-oiling, and the brushes, which require no shifting, feed on automatically. The dynamo is belted directly to the main shaft in the engine room, and runs at about 650 revolutions per minute. No attention whatever is required after the machine is started except to oil the bearings once a day. "Prof." Jonas Johnson, of 49 Cortlandt street, well known as an "electrician" and boot-black, now has a plant similar to the above in operation to illuminate his "parlors" and supply light to the tenants above.

The Improved Gramophone.*

BY EMILE BERLINER.

It might seem strange to you at first that I should commence discussing the gramophone by talking about induction; but I would like to refer to a small portion of a paper which I read before the Franklin Institute in 1888 on the gramophone, when it was first shown, in which occurs the following:

"In my telephonic studies I had become familiar with all the causes influencing the transmission and reproduction of the voice, and what had at all times struck me as forcibly as anything in telephonic phenomena was the fact that the self-induction of long iron wires or of polarized electro-magnets acted so detrimentally upon the articulation. Electric resistance alone would simply have weakened the sound, but self-induction meant retardation and thus distortion of the transmitted waves which varied in length and amplitude."

And further on:

"In considering such and other facts, it became evident to me that if such delicate energy as the voice, subdivided into, may be, several hundred waves, should indent or engrave itself into a solid body, it needed but very slight mechanical resistance to modify considerably the character of the sound vibrations, for what self-induction is to the telephone circuit, the variable resistance which impressible material offers to indentation or engraving at various depths is to the phonograph record sheet. Neither is proportional in direct ratio to the expended energy, and must give cause, aside from a reduction in size of the sound characters, also to a distortion of the same."

And that brings me right to the subject of this evening, and I start by further explaining here that those remarks had reference to the fact that in the phonograph it was impossible to make a loud reproduction which at the same time would be natural in tone. So long as you confine yourself to the small telephone voice the sound is natural and very satisfactory, but as soon as you attempt to indent at greater depth the waves are distorted and the sound becomes unnatural. In the gramophone, as you will further on see, and I suppose you are perfectly familar with the principle, there is no indenting and no engraving, but there is a constant resistance, that of the light pressure of an elastic blade on a flat surface, or on a cylinder, if you please, but whatever resistance there may be in it is constant. And that is the principal difference, speaking scientifically, between the phonograph and the gramophone, that in one you have a variable resistance, in the other a constant resistance.

In May, 1888, before a meeting of the Franklin Institute in Philadelphia, I showed publicly for the first time how sound records could be etched in metal, and how the original sound could again be made audible from such etchings. What I there demonstrated was of necessity crude in its effects, because embodied in the invention were a number of entirely new processes, new principles of construction and an art which dealt with motions infinitesimally small, the effects of which cannot altogether be either seen or measured; all of which was brought to bear on the single problem of fixing forever and with as much resemblance to nature as possible, both in loudness and quality, the sounds of instruments, of noises of all kinds, and of that delicate and subtle form of energy called the human voice.

At the same meeting I read a lengthy paper dealing with the history of the twin arts, that of transmitting sound electrically, and that of recording and reproducing the same mechanically. That the development of both arts occurred as I then showed—in parallel steps—is not the only excuse for bringing talking machines before electrical societies.

In the gramophone, at least, there occur materials and processes which, partly or wholly electrical, comprise terms familiar to every electrical engineer. Zinc, acid, bichromate of potash, diaphragms, dampers, electrotyping, all these play their part in the technique of the gramophone, not to speak of the possibility of applying electric motors to drive the machines, and of using the electric current for rapid etching.

The science of electricity almost began with immersing zinc in acid, but crude force alone is thereby set free, while in the gramophone the action of the acid on the metal is so

* Paper read before the American Institute of Electrical Engineers, Dec. 16, 1890. The Institute is indebted for the cuts used in this paper to the *Scientific American*, in which they were printed some time ago.

curbed and regulated that under it the zinc becomes a picture of sound waves, which, though slumbering in a bed of hard metal, is ready at any time, even centuries hence, to burst forth into the soft cadenzas of word and song, the ripple of laughter, the strains of martial music, as well as the melancholy and imploring drag of the organ-grinder's tuneful melody.

The hydrogen. which would otherwise be set free, is neutralized by the well-known depolarizer, chromic acid, and the carrier of the recorded sound waves is so perfectly and yet so delicately insulated from the action of the acid that a spiral of sound undulations 600 feet in length could, without difficulty, be traced and etched on an eight-inch disc, and would represent when reprodued a continuous conversation lasting seven minutes; all this automatically, and with far greater facility than is possible in making a photograph picture.

In the art of etching, that which insulates the metal from the action of the acid is called an etching-ground, and in the gramophone this etching-ground is a very delicate fatty film, deposited from the fluid state upon the metal surface. This fluid is made as follows: Into a bottle containing one quart of gasoline, benzine, or petroleum ether, are put two ounces of scraped, dark yellow beeswax, and allowed to digest, with occasional stirring, for several hours. We shall then find a clear yellow fluid on the top, and a white cheese-like precipitate at the bottom. The clear fluid is decanted or siphoned off into another bottle, and diluted with the same quantity of gasoline.

When this fluid is poured on an absolutely clean and slightly warmed metal surface, there remains after the gasoline has evaporated a delicate fatty film, very porous, and so thin that it shines in iridescent colors. It is somewhat tenacious to the touch, but loses its resistance in a remarkable degree when alcohol is poured over it. As soon, however, as the alcohol is washed off with water, the film assumes again its tenacious quality with but very small loss in weight, due to its dissolving slightly in alcohol.

As this etching-ground forms one of the keys to the whole gramophonic art, I will illustrate its qualities by the following experiment:

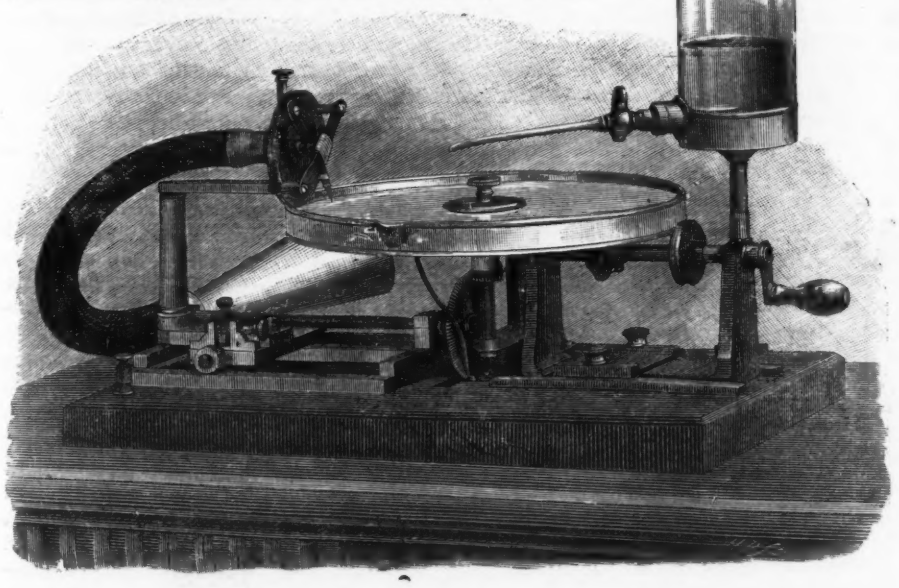


FIG. 1.—MAKING A GRAMOPHONE RECORD.

I have here a strip of zinc, over which the fatty film above described has been deposited from the solution of waxy fat. I have here also a piece of blotting paper, and with its edge touching the film, I now draw several cross-lines on the zinc. Next I pour alcohol over it and draw a single line over the length of the strip, taking care to touch the surface as lightly as possible. I now wash off the alcohol and plunge the strip into this glass containing a solution of chromic acid, and you will presently see the long line appearing as a dark streak on the zinc, while the cross-lines appear less marked and more reluctantly, showing that the film offered less resistance under the alcohol than without it.

When, after about 10 minutes, we take the strip out, we will find under a magnifying glass that the track of each cotton fibre of which the blotting paper consists is sharply etched into the zinc; the rest of the metal has remained entirely untouched. Such is the nature of the etching ground used in the gramophone for etching sound records.

I will now illustrate how such records are produced, but I would like first to recapitulate briefly what I dealt with at length before the Franklin Institute, relating to the history of the art of making sound-records of the human voice. That dates back to the year 1857, when Leon Scott patented his phonautograph, which is described in every book on physical science. It consisted, as you see on that picture yonder, of a cylinder mounted on a screw and turned by hand, a barrel-shaped mouthpiece, a diaphragm provided with a damping device, a flexible stylus attached to the centre of the diaphragm and means of adjusting the position of stylus and record sheet to each other. The cylinder is covered with paper smoked with an oily flame, after which the stylus is so adjusted that it presses lightly on the smoked surface. When the cylinder is now revolved, the stylus traces a spiral line on the paper, and when at the same time, sound enters the barrel, the diaphragm will vibrate and the spiral line assume an undulatory form, according to the nature and pitch of the sound emitted.

Such tracings of sound are called "phonautograms," but since I have found that those published as having been made by the phonautograph are not true curves of the sounds they were supposed to represent, I have here some which are more correct, and drawn from gramophone records, representing some of the more prominent vowels. The waves are complex in character, and between 75 to 150

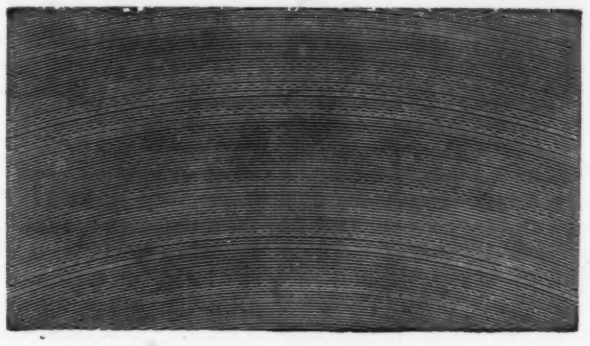


FIG. 3.—FACSIMILE OF ETCHED DISC.

of these compound waves follow each other per second in the pitch of the ordinary human voice; all of which is well known, and described in the chapters on sound of physical science.

In the spring of 1877, and following in the wake of the invention of the speaking telephone, it occurred to Charles Cros, of Paris, that if such sound-tracings could be engraved, for instance, by the photo-engraving method, and the stylus be then permitted to travel again in the groove or track of these engraved record lines, by revolving the cylinder past the stylus, the original sound would be reproduced. This was about six months before the invention of the phonograph, but the technical difficulties which appear in the attempt to bring about the desired result must have seemed too great to Cros; or he must have gotten discouraged later on, seeing the apparently simpler method of the phonograph. At any rate, it appears that he never accomplished what he had conceived with such astute logic, and his paper on the subject (which can

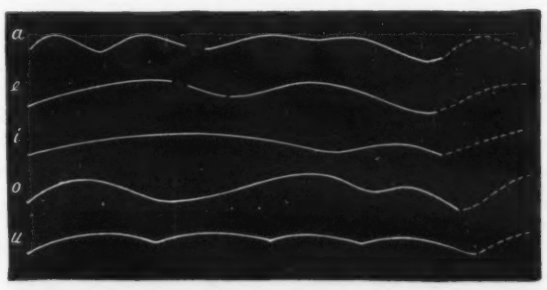


FIG. 4—.GRAMOPHONE RECORD OF THE VOWELS.

be found in the *Comptes Rendus*) was barely noticed, and quickly forgotten.

It was not until after the granting of the patent for the gramophone that I happened to see a reference to it, and searching the *Comptes Rendus* found the article mentioned, which I then translated and embodied verbatim in my paper before the Franklin Institute. While, however, Cros had a correct conception of the general principle of a talking machine, it would have required considerable modification of the rules taught by physical science which were then at his command to obtain practical results; but I will illustrate what he meant, with this model built on the principle of the gramophone.

Here is a drum-head of oil-cloth, and across it, and pivoted at the top, is an arm or stylus, which is connected to the centre of the drum, and therefore, moves with the latter. The free end of the arm extends beyond the periphery of the drum, and carries a brush dipped in ink.

If I now pass a strip of paper underneath the brush and at the same time move the drum regularly to and fro, an undulatory line of regular character will be drawn on the paper. If I repeat the experiment, but more irregularly, or jerky, the motions of the drum appear marked down as a jerky, irregular line.

I now replace the brush by a hard stick and permit it to travel in an undulatory groove engraved in a strip of wood, which strip I draw underneath the stick, and you will see by the reflection of light on the oil-cloth drum, that it is moved to and fro by the engraved wave-line, and if these motions should occur rapidly enough, a sound would be emitted by the drum.

This illustrates the general principle of the gramophone. It is, however, in the method of engraving the sound-records that the gramophone departs materially from the previous methods, and this I will now show you. Here is a disc of ordinary zinc, such as you can buy in every tin shop; it has been polished, carefully cleaned, and has then been coated with our fatty film. I now place the zinc on the turn-table of the gramophone recorder. The turn-table is revolved by a friction-wheel underneath, and connects through gearing with a screw, which propels a carriage across the turn-table, at a slow rate of progression. On this carriage is mounted the recorder proper, namely, a mica diaphragm, across which lies a spring, fastened above and carrying at the lower free end a slender metallic blade, bent downward slightly, and tipped with iridium, like a gold pen. This blade I now bring down upon the fatty film until it is straightened.

Mounted near the turn-table is a bottle containing alcohol, from which a spout extends to the centre of the turn-table, dropping the fluid upon the fatty film on which I first pour some of it, so as to soak it.

If I now revolve the turn-table the blade or pen marks a plain line into the fatty film, and as the iridium tip is kept free from the dust fibres which are continually floating about in the air, and upon the film also, by the presence of the alcohol, the line in proper light appears as a fine silvery streak in the dull fatty surface, showing that the metal is being laid bare by the iridium tip.

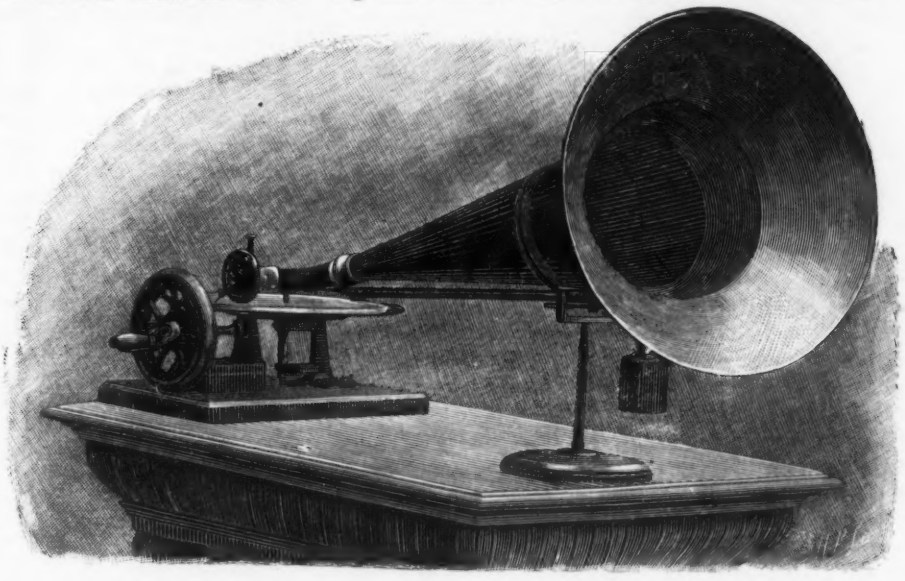


FIG. 2.—REPRODUCING A GRAMOPHONE RECORD.

If, now, sound enters the tube leading to the diaphram, the latter will vibrate and the line will assume the undulatory form of sound waves, as before explained.

The gearing of the machine is at present set so that 72 lines are drawn to the inch; but for the ordinary conversational tone, the lines might be twice as close together without the waves touching. The turn-table revolves at the rate of about 60 times a minute for this size of disc, and if they are smaller the velocity must be increased, so as not to crowd the waves too close upon one another.

The talking being done, I lift the disc from the machine and dip it in water, which washes off the alcohol, and there is now visible a band of silver lines in the fatty film. I may now write the date in the central portion of the disc and press the patent stamp on it, or add any other remark or signature, all of which will be subsequently etched in, and I may now plunge the disc into the bath of chromic acid. Immediately the acid attacks the zinc in the lines, and a dark cloud forms over the record, due to the formation of a subchromate of zinc.

While the disc is being etched, let me now turn to the reproducing machine. The principal part is again a turn-table moved by a friction-wheel underneath. Above it is an arm pivoted with one end upon a standard having a double or universal motion, and the other end carries the reproducer proper, namely, a diaphragm of mica, vulcanite fibre, rubber, or ivory, across which is fixed at its upper end, a stiff spring connected by a post to the centre of the diaphragm, its free end extending beyond the periphery, and carrying a small steel needle which may easily be taken out and replaced when necessary. This pivoted arm is the invention of Mr. Werner Suess, of Washington.

One of the mechanical curiosities of the gramophone is the fact that the etched record itself is the screw which propels the diaphragm from periphery to centre, for the

stylus resting in the groove by gravity or slight pressure, not only is vibrated, but following it and being able to move freely, is led along to the centre and to the end of the etched record automatically. This places the gramophone reproducer in the realm of extreme simplicity, and beyond the necessity of repair under ordinary everyday conditions.

Before proceeding further, I will now let the gramophone show you some of the results of what it is capable of doing at the present time. I should like to remark, that in the present form of the resonator the sharpness of the effects is somewhat toned down. That this is due to the resonator will become more apparent to you when, later in the evening, you will listen to some of the discs through the rubber ear-tubes. It has been proposed to use a resonator in the form of a large parabolic reflector, so as to enlarge the effects without modifying the timbre. But the effects, although loud, show the natural qualities of the various sounds, and are, in spite of their loudness, neither rasping nor ventriloquistic in quality.

The possibilities of extending the gramophonic principle are perhaps more noteworthy than its present development. The discs can be easily duplicated, and at the first exhibition in Philadelphia I showed an electrotype copy of a 12-inch disc which sounded precisely like the original. Since then I have also succeeded in making talking copies by pressing a matrix into molten glass, but the matrix being of copper the glass used to stick to the form, and warped the glass copy. I am assured, however, that whenever I shall furnish a steel matrix the perfect copying in glass will be entirely feasible. That such steel matrices can be made is not doubted by those familiar with the art of transferring lines, and then etching the same.

We may then have dinner sets the dessert plates of which have gramophone records pressed in them, and which will furnish the after-dinner entertainment when the repast is over. Gramophone plaques with the voices of eminent people will adorn our parlors and libraries.

Very successful copies have been made in celluloid from electrotype matrices, and such celluloid copies are particularly free from all frictional noise, provided the celluloid is pressed hard and of well-seasoned material. Gramophone records have been printed, and such prints have been photo-engraved, and the copy thus obtained sounded precisely like the original.

Successful copies have been made by letting one disc sing or talk to another one by coupling the recorder to the reproducer by a tube, and turning both simultaneously. In fact, this whole matter of duplicating discs is a department in itself, and would require a separate evening to do it full justice.

The work of gradually bringing the gramophone up to the present state has been exceedingly tedious. Working out telephones or transmitters is child's-play in the face of the traps and Jack-o'-lanterns which beset the experiments with talking machines. The size, form and material of the mouth-piece, the density, length and diameter of the speaking tube, the size, thickness and material of the diaphragms, the tension, temper and thickness of the springs, shape of the needle points, temperature of the room in which the discs are coated, the quality of the beeswax, the strength of the acid, and the method of manipulating the sound of voices and of various instruments—all these gave rise to errors and pitfalls, which only continuous repetitions of whole series of tests could locate, avoid or obliterate.

I have to dwell on these facts, in order to ask your indulgence in not having been able for this evening to cover the important field of copying records, but I have also been disappointed in not receiving a number of celluloid discs, such as are now being made in Germany.

The important subject of good articulation has ever been kept in the foreground, and this is now in so satisfactory a shape that I am carrying on a vocal correspondence with my friends in Europe, by means of small gramophone discs, which can be mailed in a good sized letter envelope.

Foremost among the feats which the gramophone can perform is the absolute certainty with which it enables people to recognize the speaker's voice, and I could cite a number of instances where persons have been made happy by hearing and recognizing the voices of loved ones whom they had not seen in years, and the owners of which were thousands of miles away.

This whole art is now manipulated with great certainty, and can be learned much easier than the art of photography. Yet, favorably as I believe the gramophone compares with other talking machines, it has barely entered upon the possibilities which lie dormant within its principles, only awaiting the touch of investigation to yield new and important scientific data.

Its advantages at the present time can be summed up as follows:

1. The records are durable, and require a minimum of space for storing.
2. Recognition is perfect.
3. The mechanism of the reproducing machine is a model of simplicity.
4. The records can be printed, and from such prints copies can be made which will sound like the original.
5. The quality of the sounds does not become impaired with increasing loudness.
6. The making of copies is possible by several well-known methods in existing arts.

Lastly, I ought to again refer to the possibilities of enlarging the record lines by the photo-engraving process, and thereby rendering the sounds with increased loudness.

Whatever the art of gramophony represents at the present time does not consist of accidental results, but the principles and the errors to be avoided are well-known and established, and not a month passes but that new light is thrown on hitherto obscure sections of manipulation, and after three years of work, in which numberless sources of error have been eliminated, the art of etching records has lost none of its attraction, rather fascinating the mind by presenting the possibility of unlimited applications in the service and for the pleasure of mankind.

Electrical Units of the Present and Future.*

BY PROF. FRANCIS B. CROCKER.

The subject of my lecture is unfortunately, but necessarily, a dry and somewhat difficult one. My only excuse for presenting it to you is the fact that it is certainly a matter of fundamental importance, and also that it is one about which most electrical men are, to say the least, not perfectly and clearly informed. It is a matter which usually one has no opportunity to learn. When most of the men in the electrical profession obtained their education they picked it up, so to speak, as there were no regular courses of electrical instruction. In picking up information it is usually very hard to get, and one is apt to postpone it. No time comes for sitting down and finding out how the electrical units were derived, what they mean, and how they are related to each other, etc., etc.

The complicated and unattractive condition of the subject of electric units is partly due to the fact that it is a growth, and partly due to the fact that it is naturally and inherently a heavy subject. If to-day a system of units were to be devised, it would probably not be the present one. But the best system that could be devised would be difficult and complicated.

The matter of electrical units and electrical measurements is precisely similar to all other measurements. What is true of electrical measurements is true of others; in fact, electrical measurements are derived directly from ordinary measurements. If we go back historically to the origin of the subject, we find that in ancient times men did not require exact measurements. Numerous facts were presented to the view then as now, but men were satisfied with rough ideas. For example, even at the present time we know a physical fact just as well whether we measure it or not. I know the existence of the Hudson River or the Capitol at Washington just as well, whether I measure it not. I think that is a point that is not generally realized—the fact that we may perfectly and clearly know a thing without measuring it, although physicists are apt to think that unless we measure it we know nothing about it. But as soon as we come to definite work, either in science or commerce, measurement is everything, and the mere existence of the thing is of little consequence compared with its value. For example, in the case of a steam engine, the whole question is whether it is one or twenty or a thousand horse power. Its mere existence is not important, and no one would buy a steam engine, or think of considering a steam engine, except in the most careless way, without knowing its power. It depends on circumstances whether we need measure things or not.

To measure quantities of any kind some unit is needed. In the crude ancient days that I referred to, the roughest kinds of units were sufficient. The length of the king's foot, of a barleycorn, or the side of some temple, or a stone in a pyramid, or something of that sort, were quite good enough for a unit. In fact, nothing better was needed. But as soon as the exact sciences developed astronomy, mechanics and other branches of science, and when commerce became more important and definite, the necessity for some more exact unit arose. The rough units I refer to are not only rough, but they are arbitrary. They might just as well select some other king's foot or some other stone in the pyramid, instead of the particular one selected. The more exact requirements of advanced work at first only required definite standards. Therefore the standard yard and the standard quart were adopted, but they were arbitrary. Some persons decided what they should be and they were carefully made and deposited in the national archives, and exact copies of those were made and sent around to various points, and they became in some cases the legal standards.

Standards can be adopted by custom or by law. Some of the standards in common use are legalized and some are not. One or more of our most common standards have not been legalized.

So far they had merely arbitrary units. The quart bore no relation to the yard; the yard bore no relation to the second, and neither of the three bore any simple relation to any other unit. That is to say, the fraction representing the relations between the two would have several decimal places. But, nevertheless, each was definite in itself. The standard yard was a definite length of metal and carefully preserved. Therefore, it was as exact as any unit can possibly be, but it had the disadvantage of having no simple relation to any other unit, and when we pass from yards to quarts and from quarts to pounds, etc., we have no convenient way of translating the quantities. We are obliged to use very awkward figures. What is needed is an *absolute system* in which the units bear exact and easily remembered relations to each other. That is the essence of what is called the absolute system. But it happens that an absolute unit is a very hard thing to obtain. It is impossible to look about and find a standard length that is derived from any source that is unquestionable. It is a matter of judgment and choice, and nothing seems to be very satisfactory for the purpose.

The waves of light would be one of the most definite and one of the most ideal sources of a system of units. Each particular point of the spectrum has a definite wave length, and it also has a definite wave rate. That would give us a unit of length and a unit of time, and from one single phenomenon we could get two units. But when the absolute system was established, wave length and wave rate were not understood; and if you will consider the thing for a moment, you will see that it is almost impossible to think of any absolute unit—anything that will be as true in Asia as it is in America, and also as true a thousand years hence as it is to-day. That is what an absolute system requires. They simply selected the best absolute unit they could get, and they were forced to take a unit based on the size of the earth. But this is not a good unit on account of the difficulty of measuring the earth. It is so large that it is extremely difficult to measure it. The first question in this system of absolute units is, what units have we got to determine. This is largely choice, and it so happens that if we fix a few units we fix all the others. The others can easily be derived. The three facts in nature which are supposed to be absolute, and that philosophers look upon as the three fundamental conditions of existence and thought, are time, space and matter. These three facts are supposed to be fundamental, and everything else is a combination of them. This may be true, or it may not be true; but so far as matter is concerned, it is a question whether there is such a thing at all. It is impossible to know of it directly. We only know of matter through force. For instance, where we take a brick—one of the most tangible things one can think of—the reason we know that it contains matter, or think that we know that it contains it, is that it is rigid, which is entirely due to the force of cohesion of its particles. One can quibble about this forever as with most other metaphysical questions, and it really does not make much difference either way. The existence of matter may be somewhat questionable, but of course there is something there that we can call matter, and we know there is time and we know there is space.

Therefore, time, space and matter were selected as the fundamental quantities, and it was necessary to find a unit for each.

Taking space or length, which amounts to the same thing, as the first, they began by measuring the circumference of the earth, or rather, a quarter of it—the earth's quadrant—which is the distance from the pole to the equator. Of course, the actual distance from the pole to the equator was not measured; they measured one degree of it, and calculated from that. These measurements were carried on with the utmost care. It took months and months of the most careful work to make them. The metal bars were laid on the ground perfectly horizontally. The temperature had to be carefully taken. The bars had to be exactly in contact, that is, just touching each other—not enough pressure to produce any strain. It would probably take days to travel a few hundred feet, and to travel 60 miles and make an exact measurement of that sort, and expect to come out within a few inches, would require exceedingly careful and protracted work. Unfortunately, an error was made that would not be of consequence in anything else, but in the case of the foundation of a system of units it amounts to something—about one one-hundredth of one per cent. Nevertheless, from that measurement the unit was determined. But the question arose what fraction of the earth's quadrant to take as the unit. Of course, it must be a round number. A ten-millionth happens to be about equal to a yard. A one hundred-millionth would be too small—about four inches. One is a little too small and the other is too large for a convenient unit of length. The foot, which is a very convenient unit of length, is between the two, but unfortunately the earth didn't lend itself to this system of units. They chose the larger one, and made the metre the standard of length. The metre is simply one ten-millionth of the earth's quadrant, as measured by the French authorities. They made exact copies of it and deposited it in Paris, which is the centre in regard to metric matters, and the various national governments are supplied with exact copies of the standard. An exact copy was sent to the United States not much more than a year ago. It was opened by the President of the United States in the presence of the officers of the government, and was a matter of considerable importance.

Having the metre, the question was to get a unit of weight. The unit of weight may easily be gotten by cubing—that is, making a volume from the unit of length and filling it with water. But a cubic metre of water would, of course, be too large for a unit of weight, as it weighs about a ton, so a fraction of it was taken. Here, again, a choice was necessary. A cubic centimetre of water was selected and called the gramme. I think that was a great mistake, because a centimetre is a very small thing and has tended to bring the whole system of absolute units into disrepute. It seems so small that it is not worth considering. I think if they had taken the decimetre, the tenth of

* Address before the New York Electric Club.

the metre, as the unit of engtb, and the cubic decimetre of water as the unit of weight, we should have very much better and more harmonious units. A metre is too large and a gramme too small. The unit of time has already been selected. The second is simply the ordinary second that is used in calculating time all over the world, and is also a very small unit. Thus we obtain the three primordial standards of length, mass and time, and since, for scientific purposes, the centimetre is taken instead of the metre, we have the centimetre, gramme and second as the three fundamental units upon which is based the C. G. S. system of units. Theoretically, and probably practically, all units of every kind, present and future, can be derived from these three simple fundamental units, which we can all understand and know just how they were obtained and what their values are. The mechanical units are very easily derived from the fundamental units. To obtain velocity, we divide length by time; that is to say, we do the same as in any other case when we say so many miles per hour, so many feet per second, etc. Acceleration, of course, is the increase of velocity. That is to say, it is distance divided by time, which is velocity, and that divided by time again, because if we increase the velocity in a certain time, that is acceleration. Force is giving acceleration to a mass, which is the Newtonian principle of measuring force. Work is simply force multiplied by distance, which again is well known. To take one pound and lift it two feet requires two foot-pounds, and so on. The electrical units are almost as easily derived, but the question is what to start with.

There are two fundamental laws of electricity. One is Coulomb's law, which applies to static electricity, and states that a certain charge of electricity attracts or repels another certain charge with a force directly proportional to the product of the quantities and inversely proportional to the square of the distance. In former times static electricity was very important. The old books were full of dolls with hair standing on end, pith-balls, etc. It happens now that static electricity does not amount to much. There is no force in it. A spark passes, and that is the end of it. We need something more constant than that. So when electricity is to be used, it should be in the form of current which lasts. The fundamental law of the electric current is that of Ampère, which states that a current affects a magnet in proportion to the strengths of the magnet and of the current, the length of the wire, and inversely proportionally to the square of its distance from the magnet. As we can measure the length of the wire and the square of the distance, hence we can get the strength of the current. But this involves having magnetic units. Here are two bar magnets supposed to be exactly alike. If I bring the north poles together they repel each other; and if the magnets were delicately suspended on silk fibres, and brought within a unit's distance, and the repulsion between them accurately measured by the torsion of the fibre or by balancing them against some other known force—a delicate spring—then I would find how many units of pole strength the magnet had. To get a unit magnetic field from this we say that a unit pole placed at a unit's distance produces a unit's strength of field. The field is the important thing in dynamo machines and many other practical cases.

To get a line of force, which, by the way, is the unit that is most used in practice, we produce the unit field and take a unit's area of it, which is called line of force. It is to a certain extent arbitrary, but it is definite, nevertheless, and that is the line of force that we use so much. We read of it in text books and even in the daily papers.

To return to measuring the current. We take a unit pole, and when it has a unit of force exerted on it by a unit length of a current at a unit's distance and a unit length then it is a unit current. Thus we pass from the quadrant of the earth to the unit of the current by several simple steps, each one of which is easy to understand and each one of which is perfectly logical and follows directly from the previous one.

From current, which is, in my opinion, the fundamental unit of useful electricity, we obtain quantity of electricity. Quantity of electricity is simply the amount of electricity that flows in a unit current for a unit time. Now, electromotive force is about the most troublesome one of these units. It means the tendency for electricity to produce a current and do work. Therefore, electromotive force multiplied by quantity of electricity would give you the work. If I have a certain electromotive force and one unit of quantity, I will have a certain work that will be measured by the electromotive force. It is exactly like steam. I can have 100 pounds pressure of steam and one cubic foot of steam; I will have a certain amount of work. If I have two cubic feet of steam at the same pressure I will get twice the work. Conversely, if I have 50 pounds pressure and two cubic feet, I will have the same amount of work, practically—a little less in the case of steam—as if I had 100 pounds pressure and one cubic foot. In other words, the product of the pressure or electromotive force by the quantity is the work. Therefore, to get the electromotive force, divide the work by the quantity.

Ohm's law gives the resistance as equal to the electromotive force divided by the current, these last two being known. From here on the derivation of the rest of the units is a mere clerical matter. For example, taking capacity as the next unit, we find it equal to quantity divided by potential; that is, the unit of capacity will hold a unit quantity at a unit potential. Work, as I have already explained above, is equal to potential times quantity. Power is rate of work. Therefore, potential multiplied by current, quantity per second, is power.

We come now to self-induction.

Self-induction is somewhat unfamiliar, nevertheless it is becoming important. Self-induction in telephone work, aerial, underground and submarine lines, dynamo armatures, dynamo field magnets, transformers and other alternating current apparatus are all practical cases of self-induction. We should consider self-induction almost as much as resistance. We have not done so heretofore, but that is no reason why we should not in the future.

It happens that there are several ways of defining self-induction, but the best way, I think, is to consider it as a counter electromotive force. That is to say, when I send a telephone current through an electromagnet the latter reacts against the current. When the current tries to go through, the magnet tries to oppose it. Therefore, the best way to define the unit self-induction is to say that it gives a unit counter electromotive force when there is a unit change of current in a unit time. The ordinary way, however, of deriving this unit is to multiply resistance by time. That seems to be an odd way to get it, but what it means is this: That self-induction is the apparent increase in resistance that we get when we try to pass a current through a circuit. If I put a current through the field magnet of a dynamo machine, it will take some time before it reaches its full strength. The magnet will resist the current very much more than the mere resistance of the wire, if it were stretched out in a straight line, due to the fact that it is formed in a coil around a piece of iron. But after the current has got flowing, so to speak, then self-induction ceases to exist. It only occurs when a change is taking place.

The absolute units have no names; they are simply designated as absolute units of electromotive force, resistance or quantity, as the case may be. This means that they are derived directly from the centimetre, gramme and second, and "dimensions" of units are mathematical ways of expressing how these fundamental quantities enter each unit. Some of them involve all three of these quantities, some involve two, and some only one. Take, for instance, area. Area is L square; that is, the square of the length; for example, a foot square is an area. Volume is L cube. Velocity is L divided by T. That is, it is L multiplied by T to the minus one power. This enables us to put them all on the same line for convenience.

We come now to the practical units. Every one of these absolute units, derived as I said, are either so small or so big that they are not useful.

It was necessary to take a certain number of a fraction of an absolute unit. In the case of resistance they took such a number of absolute units in round numbers as would most nearly approach the Siemens unit, which had been used before, and it happened to be 10^9 absolute units, which means that a billion of these little bits of absolute units will make one ohm, the practical unit of resistance, naming it after the discoverer of Ohm's law, and establishing the precedent of naming all the electric units after distinguished electrical scientific men, which rule has been followed without exception to the last unit. They call 10^8, that is, 100,000,000 absolute units of electromotive force, a volt. That approximated most closely in round numbers to the Daniell cell, which had previously been used as the unit of electromotive force. They selected the nearest units to the two units already in existence, and having fixed those, the theoretical value of the ampère followed. It is one thing to select how many practical units you will have in one practical unit and it is another thing to determine it. The whole system could have been originated without making a single experiment. The ampère can be determined experimentally very much more easily than the volt or ohm, as I said, by balancing the effect of the current on the magnet with some known force. Now, it happens that we know the force of the earth's magnetism. It is not at all difficult to find out by suspending a magnet, determining its time of swing and moment of inertia. Having determined the earth's magnetism, all you have to do is to balance the current effect on a magnet with the earth's effect on it, and knowing the earth's effect we know the current's effect, and, therefore, know the value of the current, which is the whole principle of a tangent galvanometer.

Thus the tangent galvanometer will give us the value of the current in absolute units, and if we take 10^{-1} of these we get the value in ampères. This is because the volt is 10^8 and the ohm is 10^9. Therefore, dividing one by the other, in Ohm's law, we obtain 10^{-1}. Having arrived at the current absolutely, we can also determine how much metal a current will deposit. But we cannot calculate it absolutely, however; we must determine it. I have here the exact weight of silver that one ampère will deposit in one hour. It was carefully weighed by the Assay Department of the School of Mines, and it is right to the tenth of a milligramme and weighs 4.0248 grammes. The ampère is a unit that is easily determined. The volt and the ohm require laborious work of years, and the original ohm, as determined by the British Association committee, was about 1¼ per cent. wrong, which is a pretty bad mistake for a scientific measurement.

In making actual standards of these units, the volt is the most elusive one of all. The tangent galvanometer and the silver deposition give up the ampère pretty well, and for the ohm we have a definite coil. But the volt is dependent on standard cells containing chemicals that are very apt to change. They are compounds and they are apt to decompose or change in their composition.

It happens that the unit of capacity, the farad, is a very large unit and we have to take a millionth of it to get a working unit. The microfarad is the standard and it is a pretty good size standard. It is equal to the capacity of two or three miles of the Atlantic cable. It would contain the same quantity of electricity as two or three miles of Atlantic cable, and it would take a thousand Atlantic cables to equal one farad in capacity. Therefore, you see that what is called the "practicable unit" of capacity is very impracticable. The reason the farad is so large is that we have obliged ourselves to define units in terms of one volt, one coulomb, etc. Now, with static electricity, one volt is very small. Our ordinary static charges are 100,000 volts or more; for instance, it takes about 100,000 volts to spark one inch.

Now a static spark to jump an inch is not a particularly large one. These, to take the volt to determine the unit of static capacity, make it necessary to have a tremendous capacity to hold our coulomb at that very low electrical pressure.

I would like to point out the fact that we have "absolute units" and "practical units," so called. I put both of these in quotation marks. Absolute units, as I have said, are not absolute, they are based on an arbitrary dimension of the earth incorrectly measured. Now, practical units in the same way are not practical, because we have one, the farad, that is 1,000 times greater than the greatest practical capacity in existence. Therefore, I maintain that we must have a third system of units and that is the "working" units. You could call them "commercial," but the objection to that is that they are equally used in the laboratory as in commercial work. We use a microfarad in the laboratory the same as in the office of a telephone or cable company. Therefore, they are not, strictly speaking, commercial, but they are *working* in both cases. Sometimes the working units agree with the practical and sometimes they do not. The ampère, coulomb and volt are the same, although in telegraphy we use the milliampère. Then we come to the ohm. That is, the ohm is right for most practical work, but for insulation tests we have to use a megohm. Nobody thinks of giving insulation tests except in megohms. Therefore, for that class of work, the working unit is the megohm and not what is called the practical unit.

When we come to the microfarad, there is no question. The practical unit ceases entirely to be practical, and we have to adopt the working unit, which is almost infinitely different.

The watt is a convenient unit for a great many purposes, but when we use it for large work we use the kilowatt, which, by the way, is a good way of rating dynamos, because it is fairly near a horse power.

Then we come down to the last of all—the henry, the new member of the family, and it is a question whether the working unit will be a henry or a millihenry. I did think of reducing the value of the henry to .001 of its value as given in the table; but it would have been a mistake, for the reason that, instead of having its value one second, multiplied by one ohm, we would have its value a second multiplied by a thousandth of an ohm or a hundredth of an ohm. That would be destroying the simplicity and the harmony of this system—a feature which it certainly does possess. Every one of these units is derived from every other one in the simple ratio of one to one, and in no case is there any complex relationship of a thousandth or ten-thousandth or anything of that sort. You see that the coulomb is an ampère multiplied by a second, a volt is one ampère multiplied by an ohm, a farad is a coulomb divided by a volt. A joule is a volt multiplied by a coulomb, and a henry is a second multiplied by an ohm; and to make any one of them anything would, I think, be a mistake, particularly as it would have been the only exception to the harmoniousness of the system.

Fortunately, the henry approximates a practical value. For example, a large Edison dynamo, shunt wound, will run up to one or more hundred henries. A telephone magnet will be between .01 and .1 of a henry. We could not expect that to be a very large value. An ordinary relay is several henries in value. A large induction coil is often 1,000 or more henries in value. Therefore, there is nothing preposterously small or large about the henry. It is about right. I have given in the last column of the table the actual or experimental value. That is, 4.025 grammes of silver per hour is the ampère. The volt is .926 of a Daniell cell. The legal ohm is 106 centimetres of mercury one square millimetre in cross section, etc. The unit of self-induction is equivalent to the length of the earth's quadrant. Thus we see that after starting with the earth's quadrant in this system of units, to obtain the fundamental units of length, and passing through all the mechanical units and the electric units, we finally get back to the earth's quadrant again. It is certainly quite remarkable and striking. It is a fact, nevertheless, that the unit of self-induction is properly represented by a length equal to the earth's quadrant. In fact, it has been called the quadrant and was so called by the Paris conference, which, I think, was a great unfairness to American electrical men, both living and dead, because certainly America's contributions to elec-

trical science and industry have been fully equal to those of any other country, and if England has the farad, joule and watt, named in honor of her distinguished electrical scientists, if France has the coulomb and ampère, if Germany has got the ohm, and if Italy has got the volt, I think it is certainly not unreasonable for us on this side of the Atlantic to ask for one unit, to be named after the discoverer of self-induction, Joseph Henry.

In regard to future units, which the requirements of advanced work will soon necessitate. We need a unit of the strength of a magnetic field. We can express it as so many lines of force to the square centimetre, etc., but that is a very clumsy way. If we simply call it one Franklin, it would be very preferable to a long sentence. We all have in mind the naming of some electric unit after Franklin, but, unfortunately, Franklin is not identified with magnetic work. He is identified with electrostatic work, but all the electrostatic units have been named. But, perhaps, his name may be adopted. We shall certainly require within a short time a magnetic unit defining the number of lines

FIG. 11.

of force, and we will speak of a field as so many units, and we will have a name for it; and when we use it every one will know what we mean. The naming of a new unit and giving it its value and deciding what it shall be, are very difficult questions. An error might cause considerable trouble and loss of time and all sorts of bad results, whereas the proper selection of a unit would greatly facilitate work.

This treatment of units is necessarily superficial, and all I have attempted to do is to show you the general derivation of them, starting the very first conception and coming to the present time and a little beyond; in fact, by giving you some inkling of what the probability of new units is.

Resistance Coils and Boxes: Their Construction and Use.

BY CHARLES P. FREY, CHIEF ELECTRICIAN OF THE GREELEY ELECTRICAL LABORATORY.

III.

If an excuse for trespassing on this well trodden field is required, one may be advanced on the ground that modern rheostats or testing sets are frequently constructed in such compact and portable form that the "parallelogram" disappears from one's thoughts as well as sight in the maze of intricate, hidden connections which serve to transpose the visible terminals, plugs, keys and conductors into a form best adapted for practical use and least conducive toward giving the involved principle the consideration which it deserves. Since it is always best to work understandingly, instead of in a blind mechanical way, let us examine what this principle is:

If a current is sent through a divided circuit, the conductors of which are of equal resistance, equal quantities of electricity will traverse each section. (See Fig. 9.) Let *A*, *B*, *R* and *X* represent four wires of equal length and

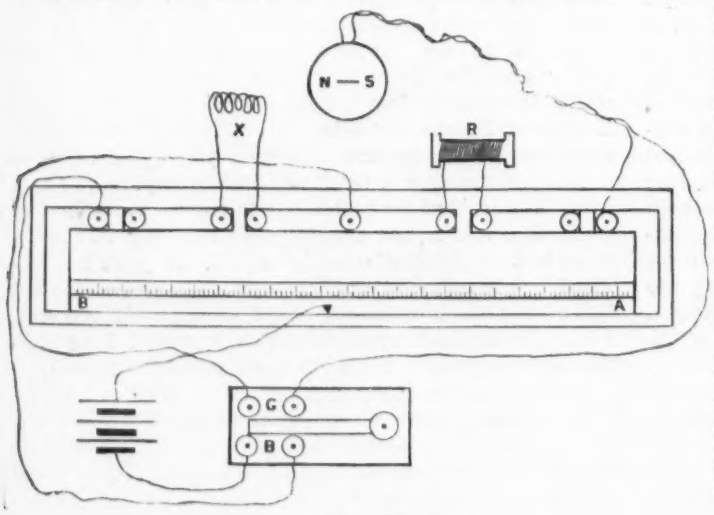


FIG. 12.

cross-section, and made of the same material (cut *A*). Then, if connected as shown, the current, starting from the copper pole of the battery (*K*) will flow through the conducting wire and divide where the conductors *A* and *B* unite, traverse *A* and *R* on one side and *B* and *X* on the other, reuniting at the lower point of the parallelogram, and completing the circuits to the zinc pole of the battery through the lower conducting wire. If a galvanometer be connected as shown, at the points between *A* and *R* on one side and *B* and *X* on the other, no current will under the given conditions flow through the galvanometer, and its needle will remain stationary.

Wheatstone's is, therefore, a "null" method, the conditions being, that before an equilibrium is established between the unknown and the known resistance the needle of the galvanometer employed will, when the circuit is closed, move either to the east or west, thereby indicating that the unknown resistance is either greater or less than the known resistance, with which it is being compared. When an equilibrium is finally obtained by varying the known or (as when a coil is "adjusted") by varying the unknown resistance until the known and unknown equal each other, no current will flow through the galvanometer, and its needle will remain stationary.

The four conductors, *A*, *B*, *R* and *X* are generally referred to as the "arms" of the bridge, and it is by the proportion subsisting between their resistances that the resistance of one of them can be determined when the resistances of the other three are known, or when one of the others is a variable known resistance and the resistances of the other two (*A* and *B*), although unknown, are known to be equal to each other.

When the current which starts (at *K*) from the battery arrives at the point where the arms *A* and *B* unite, its potential will have fallen to a certain value. The potential in the branch *A R* also falls where the arms *A* and *R* unite, and again falls till it reaches the point where *R* and *X* unite. The potential in the other branch, *B X*, falls in the same manner. Now if the two points where the galvanometer wires join are at equal potentials, or when the four arms balance one another by being in proportion, no current will flow through the galvanometer. *A* and *B* may have a greater cross section, or may be arranged in any manner so as to have each a lower or higher resistance than *R* and *X*, and yet, if they remain equal to each other, and *R* and *X* are equal (see cut *B*), the prescribed conditions are maintained, and, as before, the current will confine itself to one parallelogram. Like results are secured if *A* and *R* are equal and *B* and *X* are equal, though one side of the parallelogram may have a greater resistance than the other side (see cut *C*, Fig. 10). In fact, when an equilibrium is established, the battery and galvanometer wires may be interchanged by disconnecting, or more conveniently by a suitable commutator, and the con-

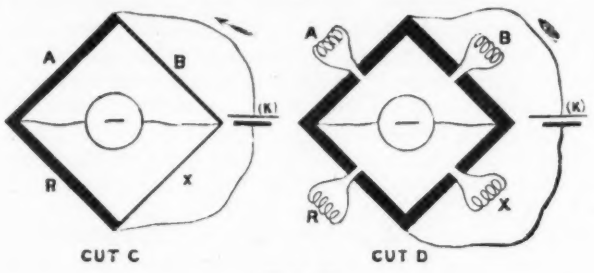


FIG. 10.

ditions will remain precisely the same. Cuts *B* and *C* illustrate this. Now, instead of representing different resistances by thick or thin lines, let us give a numerical value to *A*, *B* and *R*. We then find (cut *A*), if *A* equals 10 ohms, and *B* equals 10 ohms, and *R* equals 10 ohms, *X* must also equal 10 ohms in order to secure an equilibrium. Or (cut *B*) if *A* equals 5 ohms and *B* equals 5 ohms and *R* equals 50 ohms, *X* must also equal 50 ohms. The usual expression for this formula is: *A* is to *B* as *R* is to *X*, or substituting well-known symbols, $A : B :: R : X$. Finally, *A*, *B*, *R* and *X* may all have different resistances, and an equilibrium be still maintained, provided that, as before explained, the ratio of *A* to *B* is the same as that of *R* to *X*. For instance, if $A = 10$ ohms and $B = 100$ ohms and $R = 10$ ohms, *X* in this case must be 100 ohms. $A\ (10) : B\ (100) :: R\ (10) : X\ (100)$. In the same manner $A\ (= 81) : B\ (= 9) :: R\ (= 63) : X$; *X* being 7.

For practical purposes the parallelogram (see cut *D*) is generally constructed of well insulated material of great conductivity, having so large an area that its resistance can be ignored. With such an arrangement coils of the required resistance are fastened at apertures as shown on cut *D*. If *A* and *B* remain constant and equal to each other, the value of *X* can be ascertained by varying *R* until no current flows through the galvanometer, when, as before explained, *X* will equal *R*, or *R* the known resistance, indicate the value of *X*, the resistance to be determined.

Or if *A* and *B* are proportional to each other, the value of *X* will be to *R* as that of *B* is to *A*.

This, the fundamental principle of the Wheatstone bridge, is taken advantage of in arranging the numerous convenient contrivances for measuring resistances, known as resistance boxes, testing sets, balances, or reversible bridges, etc.

The principle of the Wheatstone bridge method of measuring resistances being understood by noting the preceding remarks, the apparatus illustrated in Figs. 11 and 12 will be found excellent for practically applying this principle, particularly in the measurement of low resistances.

The bridge consists of a wire *A B* of uniform diameter. This is fastened to heavy conductors with suitable openings and binding posts or mercury cups for inserting the standard coils and the resistance to be measured (*X*). Under or near the bridge wire is fastened a scale graduated to 1,000 parts, the extreme length of which is equal to the length of the bridge wire. Now, if this bridge is connected as shown, and contact is completed by depressing the key, any portion of the bridge wire will have a resistance directly proportional to its length. Since the current from the battery divides wherever the sliding contact rests, it follows that if two coils of equal resistance are fastened at *R* and *X* an equilibrium will be established when the sliding contact is equally distant from the extremes of the bridge wire, or, 500 divisions from each end. For, the resistance of the two coils being equal, and the bridge, though different in shape from the parallelograms used in the preceding explanations, fulfilling the same conditions, an equilibrium is established if the two halves of the bridge wire have the same resistance. And since the wire which constitutes the "bridge" is of uniform diameter, it is ap-

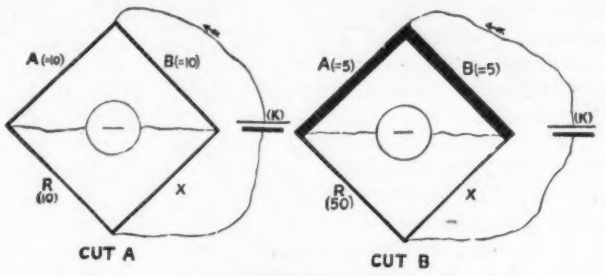


FIG. 9.

parent that equality will be maintained when the sliding contact rests mid-way between its extremes, namely, 500 divisions (or as the total length is one metre, 500 millimetres) from either extreme, which is necessarily its centre. But suppose *X* and *R* are unequal in resistance, and it is found that an equilibrium is established when the distance from *A* to the sliding contact is 750 divisions. The distance from *B* to the sliding contact is then, of course, 250 divisions. Hence the bridge is unequal. If then an equilibrium is, as before stated, established at this point, and the known resistance is 1 ohm, the resistance of *X* will be $\frac{250}{750}$ of 1, or

$$A = 750 : B = 250 : : R = 1 : X.$$

R being three times as great as *X*, or *X* equaling one-third ohm. Again let the distance from *A* to the sliding contact be 475 scale divisions, then the other length will be 525 divisions, and the resistance of *X* will be $\frac{525}{475}$ of 1. Or

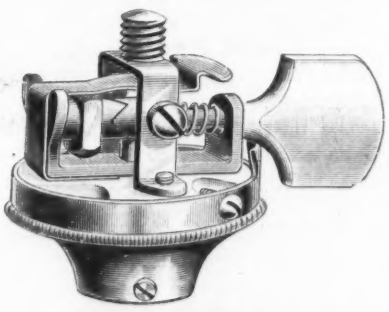
$$A = 475 : B = 525 : : R = 1 : X.$$

In this case $X = 1.1052 +$ ohms.

This apparatus is chiefly used for measuring low resistances, 1 ohm or less. When high resistances are to be measured, the resistance of the bridge wire being very small, it is necessary to add to its resistance by inserting coils of equal proportional resistance at the apertures shown on the cut. When such coils are used, the sliding contact should be allowed to remain in the centre of the bridge wire and a variable resistance used in place of the 1-ohm coil.

A Key Socket for Incandescent Lamps.

The key socket shown in the accompanying illustration is adapted by slight modifications for use in connection with the Thomson-Houston, Edison and Westinghouse lamps. One of the chief features of this socket, which is manufactured by the Electric Engineering and Supply Company, of Syracuse, N. Y., is that the insulating parts



LAMP SOCKET.

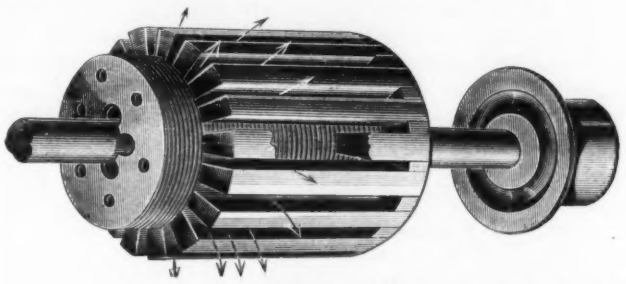
consist entirely of air spaces and a peculiar quality of porcelain, so tough that the parts may be riveted to it without breaking the porcelain.

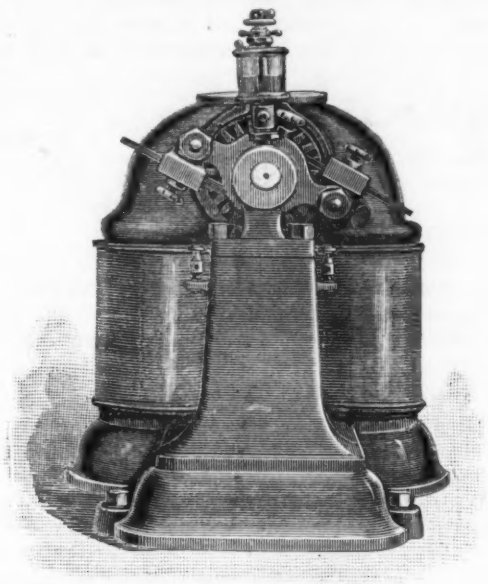
The end to which the lamp is attached has an air space insulation only. The base of the socket is of porcelain, which is non-absorbent and practically indestructible. The make and break arrangements are governed by a peculiar form of clutch, operating a cam which throws the silicon bronze contact spring, producing a slight brushing contact. The break is very sudden, owing to the peculiar operation of the clutch mechanism, and is expedited by the operation of the contact spring itself, as well as by a small spiral spring. The motion, however, is a positive one, and the sudden break, owing to the lost motion of the clutch mechanism, is as rapid as can be produced by parts operated by the two springs. Another peculiar feature of the socket is the finely finished china porcelain key as a substitute for hard rubber ordinarily used. Good insulation is provided by the use of the best material obtainable, a feature of considerable importance in all the details of an electric lighting system.

The Ford & Washburn Dynamo and Motor.

The accompanying illustrations show a new dynamo, with some of its details, which has gained considerable popularity during the past year wherever it has been introduced. It possesses some peculiar features for which the Ford & Washburn Electric Company, of Cleveland, O., which is placing it upon the market, claims a number of marked advantages.

Fig. 2 is an end view of the dynamo showing some of the features referred to. The bed plates and pillow blocks for the bearings are made of one complete casting. The magnet cores and the yoke are wrought iron fastened to the bed plate, and the pole pieces are separate castings bolted to magnet cores. The field coils are wound on separate size. The armature shaft is steel and of extra large size. shells, and are interchangeable for all machines of the same The especial feature of the dynamo is the armature, which is self-ventilating. A current of air is drawn from both ends along the line of the shaft through the holes shown in the end of the armature core in Fig. 1, and out through the discs, which are separated, and through the winding, in which openings are provided to let the current of air pass out.





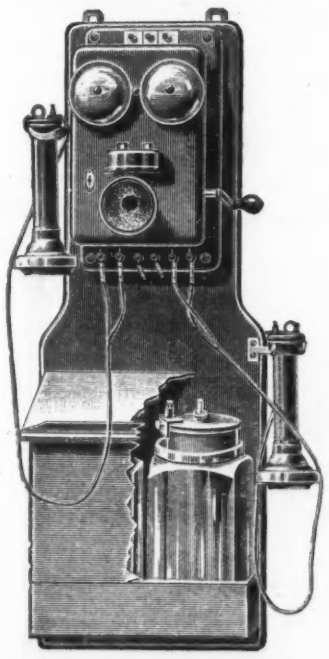
FIGS. 1 AND 2.—FORD & WASHBURN'S DYNAMO AND MOTOR.

The rapid rotary motion of the armature sends out the current of air, which keeps the armature and pole pieces cool. The arrows in Fig. 1 indicate the direction of the air current. These dynamos are said to be of high efficiency, and are compactly and substantially made.

The Berliner Transmitter.

The "universal" transmitter shown in the illustration on this page was designed by Mr. Berliner, with a view of supplying an instrument which would be efficient both as a microphone for short lines and with only one cell of Leclanché battery as well as on the longest commercial lines where several Fuller, or Bunsen, or "Accumulator" cells become necessary.

It is claimed that in the "universal" transmitter all the good requirements of a first-class instrument are combined and all sources of annoyance have been eliminated. With one cell of Leclanché it is said to work admirably and will carry the voice over a defective line where other



THE BERLINER TRANSMITTER.

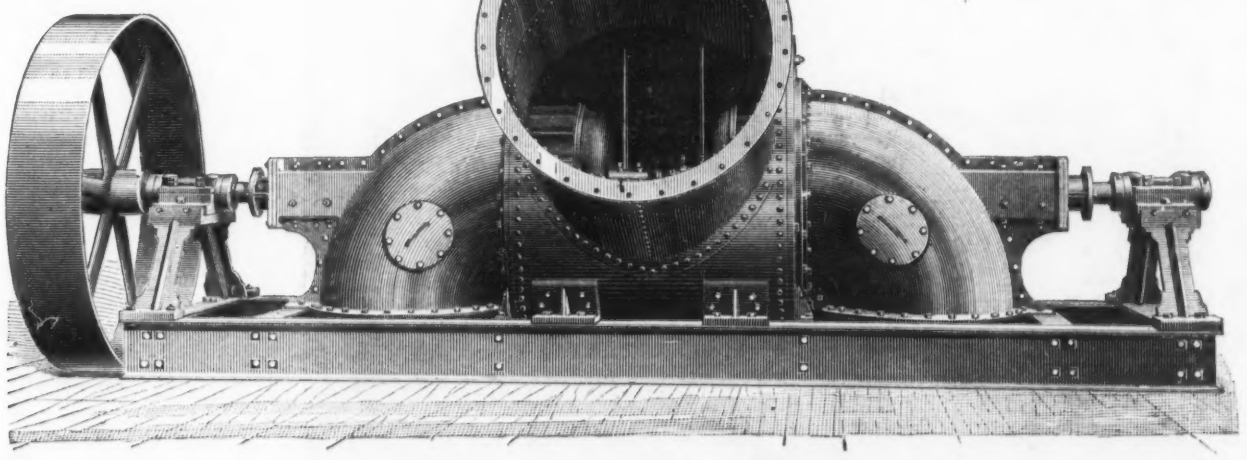
instruments fail. With three large Fuller or Bunsen cells it retains its purity of intonation and produces a volume of sound which on lines several miles long would still fill a lecture hall when a funnel resonator is applied. It may be spoken to from three to six inches from the mouthpiece with ordinary tone, or, if necessary, close to it with the loudest voice. Its internal parts, the diaphragm chamber and granules, are all carbon, with a thin covering of mica to prevent the breaking of the diaphragms. The granules when viewed under a lens show rounded corners, and the resistance of the mass is very low. A striking novelty is the use of a soft rubber mouthpiece. Special care has also been given to the construction of the induction coil, and Mr. Berliner has succeeded in producing an instrument that, while it resembles to a certain extent others that have been brought out, is capable of successfully contending with many of the troubles, such as poor insulation or induction from neighboring wires, that prevent the satisfactory action of the ordinary transmitters.

The Alcott Turbine Water Wheels on Horizontal Shaft.

To those of our readers who are interested in the development of electricity by water power any improvements in the means of hydraulic development will be of interest. The accompanying cut represents a pair of turbines mounted on a horizontal shaft. The apparatus consists essentially of a base or frame of I-beams braced substantially, and making a solid foundation of the most improved construction. Between these two girders and bolted fast thereto is a case consisting of cast heads and heavy boiler iron body, which is stiffly braced internally, making a solid casing and reducing vibration to a minimum. The quarter turns carrying water to the draft tubes and tail-race are cast iron, and are made of sufficient size to allow the change of direction of discharging water to take place slowly and easily.

The shaft is of steel, and of such proportions in diameter and so supported by bearings as to obviate any possible vibrations. The bearings are long and strong, consisting of one in the centre of the case, between the wheels, and one in the end of each quarter turn, lubricated by water, and one at each end of the frame or bed, supported on solid cast frames or yokes lubricated with oil. Adjustable steel collars at each bearing render it possible to take up any side wear, and reduce the possibility of end motion to nothing. The whole design seems admirable, both from a mechanical and a hydraulic standpoint.

The Alcott wheel, so long and favorably known to users of water power, is particularly adapted for use in horizontal shapes. The wheel proper, or runner, is made in one solid shape, without the aid of rivets or shrunk joints and



ALCOTT TURBINE WATER WHEEL.

will not, it is claimed, rust apart or shake to pieces as wheels otherwise constructed sometimes do. Great care has been exercised in the shaping of the buckets, and the curves at present adopted give the best results both at partial and full gate.

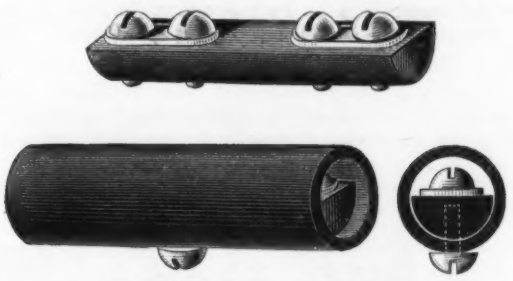
The gate is of the simplest construction, and being of the inside register pattern, it allows of being so perfectly balanced internally by a very simple device that close regulation by a governor is an easy matter. Such regulation is, of course, necessary where turbines are used to drive dynamos.

The Alcott gate possesses a particular feature in the arrangement of partial gate. It can either close a portion of each opening or entirely close one-third of all openings, leaving the other two-thirds entirely open, or it can entirely close two-thirds of all openings, leaving the other one-third entirely open.

This arrangement produces good results, for there is less friction for the same volume of water used than if a portion of each opening was closed. And the incoming column of water has the same relative angle to the bucket, and also the same relative velocity to the wheel as when the wheel is working full. This it does not have to the same extent when each opening is closed a fractional part. It is reasonable to suppose, as practice has demonstrated, that a wheel so working should give maximum partial gate results. It is no unusual sight to see valuable water power thrown away through carelessness or want of thought in designing the tail-race and the flume for carrying water to the turbines. It can reasonably be said that these parts cannot be too large, but, of course, there is a point where the interest on the improvement would more than cover the value of the additional power gained. Just where this point is must be determined for each individual plant.

A Diminutive Fixture Cut-Out.

In many cases in electrolier and gas fixture wiring the space occupied by the cut-out that is needed to conform with the requirements of the insurance companies is a matter of considerable importance, and it is often absolutely necessary to have a cut-out of very small dimen-



CUT-OUT FOR FIXTURES.

sions in order to give the work the best appearance. A cut-out that seems well adapted for such cases is that shown in the figure, the cut representing it in full size. The extreme length of the cut-out is $1\frac{9}{16}$ inches, and of the cover $1\frac{11}{16}$ inches. The external and internal diameters of the cover are respectively nine-sixteenths and seven-sixteenths of an inch. This compact and diminutive cut-out is made of hard rubber and has been brought out by the Emerson Electric Manufacturing Company. The screw which holds the cover in place is tapped into both the cut-out and the cover. While small size is its chief feature the design provides for ample fusing break, long screw threads and sufficient space inside the cover for the wire.

A New City Lighting Plant in Chicago.

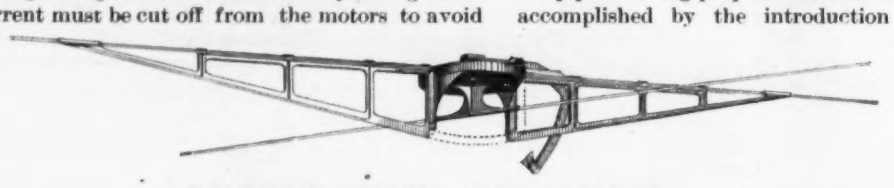
The fourth electric light station of the city of Chicago, situated at the corner of Fourteenth street and Indiana avenue, was put into service Christmas Eve, under the personal direction of Prof. J. P. Barrett, city electrician. The initial capacity is 120 lights; the running capacity of 500 lights will be attained by Jan. 1, while the building and machinery have been so designed that current can be supplied for a total of 900 lights. The four stations of the city now have the machinery required to supply 4,000 lamps, 3,000 being in nightly service. The engine used temporarily is historic from the fact that it was the first engine used for electric lighting service by the city, and is of the well-known Buckeye Engine Company's manufacture. Its nominal horse power is 120; cylinders, $14\frac{1}{2}$ inches × 16 inches; speed, 240 revolutions, taking steam at 100 pounds pressure. The dynamos were manufactured by the Western Electric Company, of Chicago, and those in use at present have an output of 60 lamps each. The boilers are a novelty in the West, and are known as the "complete combustion" boilers, made by the Portland Manufacturing Company, of Portland, Me. These are seven in number, and are of the composite type, having both fire and water tubes.

The furnaces are of the downward draft type, the grate bars being water tubes, with proper arrangement for a

positive circulation. This type of furnace is said to be smokeless. The dimensions are: Length over all, 15 feet; diameter, 6 feet 6 inches; number of tubes, 241; length of tubes, 7 feet; diameter, 2½ inches. A Berryman 300 h. p. heater supplies water at the boiling point. The Eureka cotton belting is used throughout.

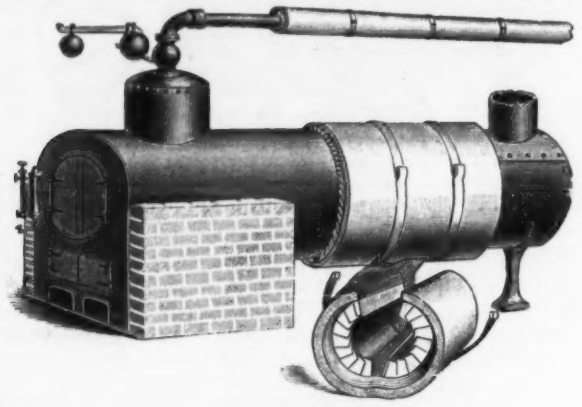
The Bagnall Trolley Wire Crossing.

In the ordinary form of crossing provided for overhead trolley lines one of the wires is so arranged that its contact with the trolley wheel is broken. When the car passes such a crossing the lights will be momentarily extinguished and the current must be cut off from the motors to avoid



BAGNALL'S TROLLEY WIRE CROSSING.

an undesirable flash between the trolley wheel and wire when the break occurs. In the trolley shown in the accompanying cut, which is put upon the market by the Emerson Electric Manufacturing Company, of St. Louis, Mo., this trouble is overcome in a very simple and ingenious way. The crossing is light, strong and graceful. Neither line is cut in placing it on the lines. It is a live



FLEGLE'S AIR SPACE COVERING.

crossing and cars can be run over it at full speed with the current turned on or off. The tongue is of steel and very strong, and of a peculiar shape, so that when it falls back it is well drawn up out of the way, and as the trolley wheel strikes it so far from the pin on which it is pivoted it has quite a leverage, and moves very easily. The tongue is brought back by gravity, and works with a positive motion. The whole thing is the result of practical experiment under severe conditions, and in practice it is found to work perfectly. Six crossings of this kind are now in use on the Lindell Railway in St. Louis. They are furnished, if necessary, with a sleet proof cap so that snow and ice can-

not interfere with the working of the tongue. The crossing is made in two styles: one for use where only a single line is crossed, and a double one where two lines are in use.

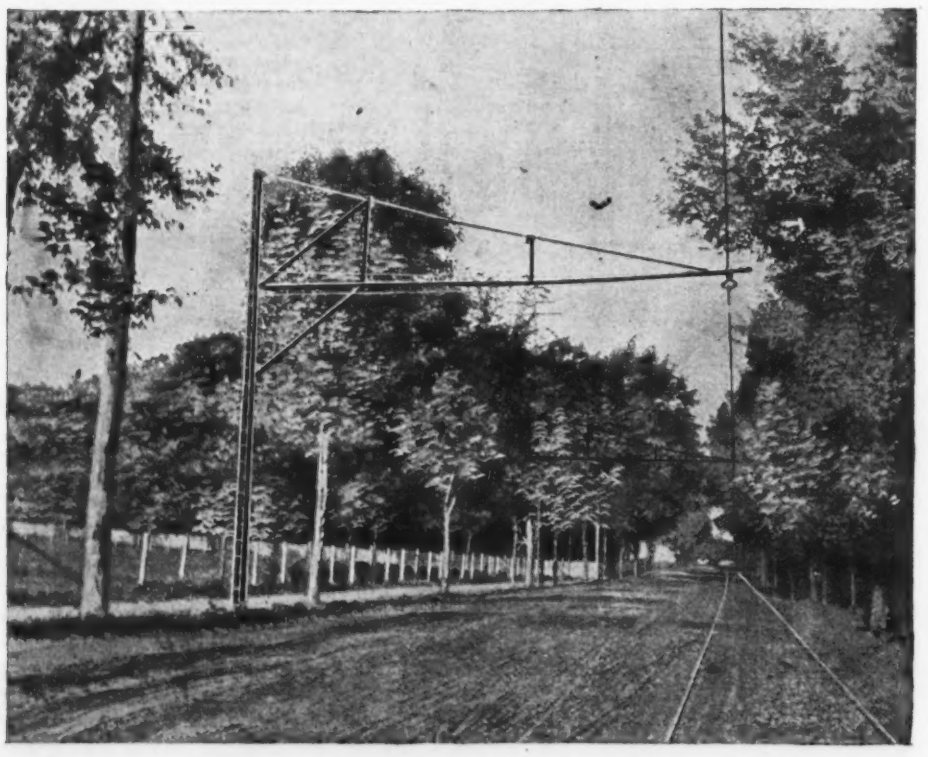
Flegle's Covering for Steam Pipes and Boilers.

The advantages of coverings for steam pipes and boilers as regards both economy and efficiency are well known to all intelligent steam users. Without some sort of good pipe covering there is always an immense loss of heat by radiation. With the ordinary steam pressure of about 80 pounds a temperature of between 300 and 400 degrees F. should be maintained at the outside surface of the steam pipe, and as this is perhaps 200 degrees above the temperature at which an engine or boiler room can be maintained it will be very readily seen that there is a very large margin for waste through radiation.

The accompanying illustration gives a clear idea of the construction and of the manner of applying a steam pipe or boiler covering which is original in many of its features and unquestionably popular among its users. It is placed upon the market by Chas. Hadesty, of St. Louis. As will be seen at a glance, the principle carried out is that of maintaining a dead air space between the heated pipe and the pipe covering proper. This is easily and successfully accomplished by the introduction of a thin metallic wrapper with flanged contact edges, holding the sides of the wrapper one-half inch from the pipe. Each section is 28 inches in length, and cut through, so as to enable the covering to be opened and sprung over the pipe, as shown in the cut. The covering inclosing the metal which forms the air space consists of sheet asbestos and paper felt one-half inch thick, the same being finished with canvas, and when painted is water proof and secures perfect insulation.

In joining the sections for covering a pipe, a non-conducting cement is used, sealing perfectly the several lengths to each other. This is accomplished all the more nicely, by reason of the edges of the covering proper slightly overlapping the ends of the metallic section. The sections may also be removed from a pipe and replaced at will, as they will always go back in line, and will not crack.

The coverings for valves, tees, ells and such fittings are made of a non-conducting cement, plastered on and neatly finished with canvas. The reason for not making sectional coverings for these fittings is because they vary so much in size, from malleable to cast iron and extra heavy, that it is impossible to fit them properly. The air space preserves the wrapper proper from the scorching, disintegrating heat of the pipe, so that coverings taken off after years of usage have been found practically as good as new.



A LONG STREET RAILWAY BRACKET.

A Long Street Railway Bracket.

The cut on this page represents what is probably the largest electrical street railway pole in the world. It was furnished by Messrs. Milliken Bros. to the Passaic, Clifton and Garfield Street Railway, at Passaic, N. J. The road runs its track on one side of the street, and some of the property owners objected to placing poles on the curb line, so the owners of the road were compelled to place the poles on the opposite side of the street and throw an arm all the way across. This presented a difficult engineering feat, and the parties, after giving the facts to Messrs. Milliken Bros., of the Pœnix Iron Company, left them to design and execute the work. There were many serious difficulties to contend with in the support and bracing of an arm of such a length on a single pole without the use of any guy wires from the pole to the ground. They used their usual form of pole and made the segments unusually heavy, extending the lacing from the bottom of the pole to the top.

The general dimensions of the pole are as follows: Length of pole, 35 feet; length of arm, 32 feet 8½ inches; height of arm above the ground, 20 feet 1½ inches; distance of pole set in the ground, 7 feet; designed to carry 500 pounds on the end of arm; total weight of pole, 2,000 pounds.

The cut does not clearly show all the connections, and the following explanation may be of interest: The arm was formed out of angle irons and plates with proper struts and rods, most of which had adjustment. The arm was also braced in a horizontal plane on the lower chord. The end of the arm has a loop, and the same at a point near its connection with the pole.

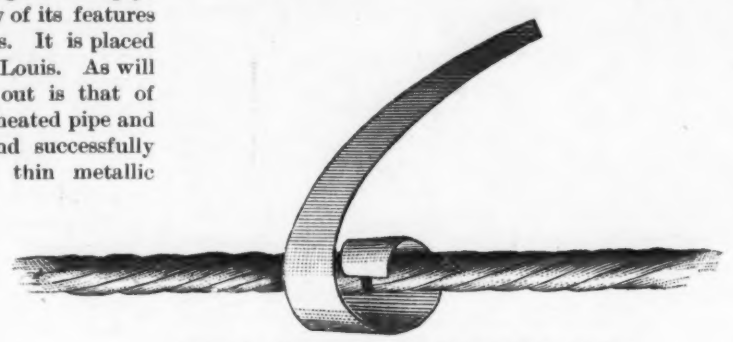
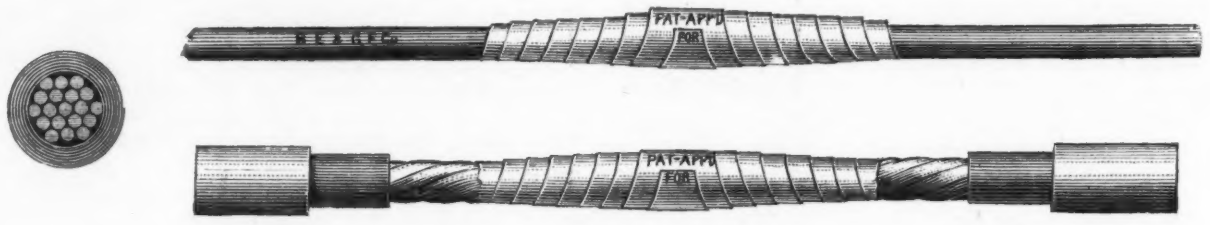


FIG. 1.—METHOD OF WINDING JOINT.



FIGS. 2, 3 AND 4.—BERGMANN WIRE JOINT.

A New Wire Joint.

The weakest and most troublesome feature of overhead line construction is probably the joint which it is necessary to make between contiguous sections of the wire. A good joint must possess sufficient strength to stand whatever strain is put upon the line and must at the same time have a conductivity equal at least to that of the line. It is also often necessary to have a joint over which insulating material may be easily placed, and if the line in which the joint occurs is a street railway trolley line it must not offer any undue mechanical resistance to the passage of the trolley wheel along the wire. A method of making a joint which seems admirably fitted to fulfill these conditions has been devised by the Bergmann Electric and Gas Fixture Company, of this city, and is herewith illustrated. The connector is merely a strip of thin sheet copper which is tightly wrapped about the joint. Fig. 1 shows

FIG. 5.—METHOD OF MAKING WIRE JOINT.

the connector about to be wrapped about the abutting ends of a cable. Figs. 2 and 3 show the appearance of the finished joint on a solid and a stranded cable respectively, and Fig. 4 is a section through the centre of the joint of a stranded cable. Fig. 5 shows the apparatus in which the ends of the wire are held while the joint is being wrapped. The two ends of the conductor are brought together and held by the clamps; the strip is then soldered to the wire and wrapped tightly around the cable ends, applying acid to each layer; the end of the strip is bound with two iron wires about three-quarters of an inch apart. The whole joint is then heated by a good flame and solder applied. It will be noticed that one advantage of such a joint is that no exact size is necessary for any given size of cable. The following table shows the results of some tests made upon cable joined together in this way:

Sample No.	No. of layers sheet copper, No. 34 B & S., covering joint.	Diam. of joint in inches.*	Area through joint, sq. in.	Area of copper strip alone, sq. in.	Joint broke at lbs.*	Breaking strain of silicon bronze trolley wire, lbs.	Lbs. per sq. in. breaking strain for copper alone.
2	15	0.465	0.1698	0.1038	2,140	3,490	20,775
3	15	0.459	0.165	0.1038	2,080	3,490	20,186
4	15	0.445	0.155	0.1038	2,800	3,490	27,182

Area of silicon bronze trolley wire, 0.043 of a sq. in.
Diameter of trolley was, wire 0.236 of an inch.
Diameter of joint was 0.450 of an inch.
* Tests made at Columbia College laboratory.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

Purpose of this Department.—With this issue the discussion of matters pertaining to the electrical stock market becomes a regular department of this journal, its purpose being to give reliable and unprejudiced opinions on the market for electrical stocks and securities from week to week and to endeavor to give persons interested in financial matters connected with the electrical business a place for ready reference where the course of stocks may be followed, together with comments thereon which will be free from the favor or prejudice of any particular stock or corporation.

The Close of the Year.—With few regrets does the financial community tear the last page from the calendar of 1890. The year that has passed has been a very trying one. Financial troubles, failures of banks and houses of wide repute, and a panic have shaken the financial centres of the world and unsettled business. Still there is much to be thankful for in the fact that although collections are slow the general business of the country has been good, and we have been blessed with good crops. If there had been a shrinkage of crops together with our financial troubles, a condition of affairs would have existed formerly unknown to the country.

The New Year brings with it much brighter prospects financially. We find a money market approaching easiness and stocks to be had at prices which are very cheap and give opportunities for money making far beyond the ordinary. An impulse will be given to dividend paying stocks particularly with the early part of the year, because of the accumulated dividends again seeking investment, and the whole list will see an upward trend, owing to the improved condition of affairs generally.

Increase of Money in Circulation.—The continuous tampering with the financial situation by politicians goes merrily on. Proposition after proposition is put before Congress. The recommendation of Senator Stanford that the government loan money to farmers on their land at a very low rate of interest would be very dangerous if carried out. The experience of the Argentine Republic in this particular has demonstrated the fallacy of the idea. The proposition that the Secretary of the Treasury buy up all the 4 per cent. bonds that the government has issued at the highest point reached by speculation is not worthy of serious consideration. Silver certificates are coming out at the rate of $5,000,000 per month. This will amount to $60.000,000 in a year, and is a substantial increase to the circulation.

The General Market.—The past week has been comparatively unimportant so far as developments to the advantage of the stock market is concerned. It has been a holiday market. The best point about it is that it has been steady. Trading has not been indulged in to any great extent, and the fluctuations were confined in most instances to ⅛ point rises or depressions.

Dividend Paying Stocks.—Many people desire at the first of the year to change investments from one stock to another, having experienced a change of mind concerning the value of stocks in which they have invested. To such persons the writer confidently recommends the consideration of investments in standard electrical stocks and securities. It is easily possible to go amiss in making these investments if proper judgment is not exercised, but with ordinary discretion it is difficult to go astray. Because a person has purchased bonds on an electric plant in a town of 2,500 population with an electric light company capitalized at $100,000, half of the stock of which is in the pockets of the promoters, and the bonds cover an inferior plant of no prospects, is no reason for believing that all electrical investments do not offer good chances for money making, but is a comment upon the judgment and discretion of the purchaser of the bonds. One can scarcely go amiss at the present time in buying almost any of the standard stocks, because the prices are below normal, and have every prospect of a rising market besides paying their dividends.

Edison Stock.—The proposition to increase the capital of the Edison Company from $12,000,000 to $15,000,000 is not without merit. The company is doing a great and growing business and needs the money that will be obtained for the handling of new business. Edison stock has been rather inactive during the week owing to the fact that the holidays are upon us. It closed at 85, which is a rise for the week of one point. There is every indication that the stock will continue on its upward course.

Cable Stocks.—These stocks have remained steady during the week. The study of their capitalization and the price asked for them is of interest. They pay their dividends regularly and one of them is making 16 per cent. upon its capitalization.

Western Union.—This stock has followed the course of the general market during the week and has been inactive. The closing bid was 74½, which is one-half point below last week's report. This stock is cheap at the figure quoted.

Thomson-Houston.—The statement given out by this company shows that it has sold since last February $6,500,000 of its securities. Its net cash income from sale of common stock, preferred stock, and bonds together with net earnings should be about $10,000,000. Balances taken Nov. 1 showed the company as standing about as follows: Floating debt, $2,522,388; assets, $18,000,000, including $6,000,000; open accounts, $375,000 cash and $1,850,000 due before April, 1891, for stocks and bonds already sold. The patents are put in for $310,000. It is stated that the Thomson Houston directors announce that no dividend will be declared until the last payment has been made on its foreign contract, which, it is expected, will be about March 1. The time for the payment has been extended on account of the recent stringency in the London money market.

Westinghouse.—The stock of the Westinghouse Company has been looking up a little this week, and it is anticipated by all interested that it will continue on its upward course. The closing price was 13¼ on Friday, and it has been firm all the week. The statement of the company shows capital issued, $6,500,000; gross receipts, $5,000,000; net receipts, $500,000; accounts receivable, $1,436.000; material in stock at cost, $800,000.

Telephone Stocks have been inactive, but have held prices very well. Bell Telephone dropped one point, Erie has gained ¾ of a point and New England ½ over last week. F. Z. M.

The Closing Quotations of electric stocks, from F. Z. Maguire & Co., electrical securities, 18 Wall street, New York, on Saturday, Dec. 27, 1890, in New York, Boston and Washington, and in Pittsburgh Dec. 26, were:

Name of Stock.	Par.	Capitalization.	Bid.	Ask'd.
NEW YORK.				
Western Union Telegraph Co	100	86,200,000	74½	75¾
American Telegraph & Cable	100	14,000,000	83	85
Central and South American	100	5,000,000	....	....
Mexican	100	2,000,000	....	2.15
Commercial Cable Co	100	7,716,000	1.02½	1.03
Postal Telegraph Cable	100	5,00,0000	39	41
Edison General Electric Co	100	9,503,500	85	88
" " Deferred	100	2,496,500	....	....
Consolidated Electric Light	100	1,922.400	....	....
Edison Electric Illuminating Co	100	2,567,800	70	....
United States Electric Light	100	1,500,000	30	....
North American Phonograph	100	6.200.000	....	35
BOSTON.				
Thomson-Houston Electric Co	25	6,000,000	41	41½
" " preferred	25	4,000,000	26	26½
" " Series C	10	400,000	...	11½
" " Series D	10	120,000	5¾	6
" International Co	100	350,000	....	....
Thomson Welding Co	100	1,000,000	....	200
" European Welding Co	100	1,500,000	50	60
Ft. Wayne Electric Co	25	4,000,000	10½	....
Telephone:				
American Bell	100	12.500,000	210	212
Erie	100	4,800,000	46¾	47
New England	100	10,304,600	49	....
Mexican	10	1,280,000	65c.	....
Tropical American	10	400,000	....	1¼
MISCELLANEOUS				
Edison Phonograph Doll	10	1,000,000	....	2
WASHINGTON.				
Pennsylvania Telephone	50	750,000	25	35
Chesapeake & Potomac	100	2,650,000	....	72
American Graphophone	10	600,000	11¾	12
United States Electric Light (Washington)	100	300,000	135	145
Eckington and Soldiers' Home Electric Ry	50	352,000	58	60
Georgetown and Tennallytown	50	200,000	47	55
PITTSBURGH.				
Westinghouse Electric Mfg. Co	50	5,000,000	13¼	13⅜

Col. S. G. Lynch, broker, of 153 Monroe street, Chicago, furnishes quotations on telephone stocks as follows:

Chicago	$298@$300	Cumberland	$ 59@ $60
Central Union	57@ 58	Wisconsin	118@ 120
Michigan	91@ 93	Bell of Missouri	155@ 160
Great Southern	32@ 35	Iowa Union	20@ 21
Colorado	38@ 40	Missouri and Kansas	55@ 57
Rocky Mountain Bell	40@ 45		
ELECTRIC LIGHT STOCKS.			
Chicago Arc Light and Power	$85@$90	Chicago Edison Co	$128@$130

NEW INCORPORATIONS.

The Sharpsville (Pa.) Electric Company has been incorporated with a capital stock of $15,000.

The Titusville (Fla.) Electric Light Company has been incorporated and will build a plant at once.

The Michigan Traction and Electric Company at Saginaw, Mich., has been incorporated with a capital stock of $100,000.

The Citizens' Electric Light and Power Company, at Manistee, Mich., has been incorporated with a capital stock of $15,000.

The Lake Superior Electric Construction and Supply Company, at Marquette, Mich., has been incorporated with a capital stock of $200,000.

The Chehalis (Wash.) Light and Power Company has been formed with a capital of $60,000, and will put in an electric-lighting plant immediately.

The Chicago Incandescent Light and Wiring Company has been incorporated with a capital stock of $10,000 by Lewis B. Scott, Chas. P. Emmons and Geo. N. Lyman.

The San Diego Electric Transit and Power Company has been organized at San Diego, Cal. Capital stock, $1,000,000. Directors, H. P. Palmerston, S. G. Havermale, J. W. Collins, John C. Fisher and D. D. Dare.

The Stevenson-Hoggson Electric Light Company has been incorporated at St. Louis, Mo., with $100,000 capital, by W. H. Stevenson and Samuel H. Hoggson. Early in the spring a large plant will be built, to cost several thousand dollars.

A South American Company.—Empressa del Alumbrado Electrico di Cartegnia y Barronquilla is the name of a corporation with an office in Jersey City, which proposes to do business in South America in erecting and operating electric light plants, and sell and operate dynamos, moters, telegraph and telephone apparatus.

Montclair, N. J.—Articles of incorporation of the Montclair Electric Light Company, with a capital stock of $20,000, have been filed with the county recorder. The incorporators are Messrs. H. W. Lawrence, W. F. Reed and W. C. Howe, who have secured the exclusive franchise for street and residence lighting in the town of Montclair.

Auburn Park, Ill.—The Auburn Park Electric Light, Power, Heat and Railroad Company has been incorporated with a capital of $30,000, with B. F. Cronkrite, E. W. Johnson and George E. Farley as incorporators. The object is to furnish electricity for lighting, heat and power and to establish and operate a system of electric street railways. No routes have been selected as yet.

The Pasadena (Cal.) Electric Light and Power Company has decided to increase the bonded indebtedness $20,000 or $25,000, and make a number of improvements. The present officers of the company are: M. E. Wood, president; L. C. Torrance, secretary; First National Bank, treasurer; M. E. Wood, L. C. Torrance, Col. J. Banbury, R. Doty, L. J. Crowell, G. M. Lindsay and George H. Rogers, directors.

Farmville, Va.—The Electric Light, Heat and Power Company, of Farmville, has been organized with a capital stock of $100,000. C. M. Walker, of Farmville, is president; W. L. Patterson, of Boston, Mass., general manager; J. M. Crute, of Farmville, secretary and treasurer, and the directors are: Messrs. C. M. Walker, A. D. Watkins, J. A. Sexton, Peter Winston, P. A. Irving, W. G. Venable and H. B. Campbell. Negotiations are pending with the authorities for the immediate establishment of these improvements.

Norfolk, Va.—The Norfolk and Eastern Investment Company, with a capital stock of $1,000,000, has been incorporated, with John G. Hoyt, of New York, as president; H. B. Colburn, of Bedford City, vice-president; George W. Block, of Norfolk, treasurer; Carter Berkley, of Staunton, manager; W. D. Pender, of Norfolk, secretary and attorney; and the above, with L. B. Treadwell of Rahway, New Jersey; Wm. H. Hoyt, of Tarrytown, N. Y.; S. L. Pender, of Norfolk, and W. P. Gay, of Staunton, directors. This company is empowered by its charter to establish electric light plants and other enterprises.

AFFAIRS OF THE COMPANIES.

To Issue Bonds.—The Common Council of Appleton, Wis., has determined to issue bonds for $43,000 to pay for an electric light plant for public lighting.

The Bangor Electric Light and Power Company has declared a dividend of 15 per cent., covering 1888 and 1889, payable Jan. 1, 1891. This will leave a surplus of about $8,000, and the company has voted to pay semi-annual dividends of four per cent., commencing July 1, 1891.

The Consolidated Electric Light and Power Company, of Kansas City, Mo., has issued a limited amount of 10-year 6 per cent. first mortgage bonds, which are offered as an investment by the Commonwealth Loan and Trust Company, at No. 131 Devonshire street, Boston. The interest is paid by the revenue from the city, and the present net earnings are said to be largely in excess of the amount required for its payment.

To Increase its Capital.—At a special meeting of the stockholders of the West End Street Railway Company, of Boston, Mass., held last Saturday, it was voted to authorize the directors to petition the railroad commissioners for leave to increase the capital stock of the company by the amount of $4,500,000, divided into 90,000 shares of common stock, to enable the company to pay for construction and increase of property, and in particular for expenses of introducing and perfecting the electric system.

A Denial.—Respecting the rumor that the Western Union has bought the Postal Telegraph Company, officials of the latter company are reported as saying: "There is no foundation for such a report. There is none of our stock for sale, and it is not listed on the New York Stock Exchange. The property is not for sale, and so far as is known, no one wants to buy it. We have built 4,000 miles of line this year, and are pushing work towards Texas, the only section of the country not covered by our system."

Westinghouse Finances.—The statement of the committee appointed by Pittsburgh bankers to inquire into the condition of the eight Westinghouse corporations, and upon which it was decided to loan half a million dollars, was made public last Saturday evening. It is recommended that an advisory committee, consisting of five persons, be appointed to receive the subscription fund, which amounts to $520,000, or $20,000 more than was asked for. Certificates are to be issued for the subscriptions, and the committee is to have absolute power to use the money as it shall see fit, and as may be agreed upon between it and Mr. Westinghouse.

Two Large Mortgages.—The United Electric Traction Company of this city has recorded two large mortgages. The first is given to the Mercantile Trust Company as trustee to secure bonds of the company, and is for $700,000. It covers all the company's real estate in Hudson and Bergen and other New Jersey counties, the works at Marion, the stock and machinery, rolling stock and all property of the company. The same company has also filed a chattel mortgage for $700,000. It is given to Charles W. Gould, trustee, to secure bonds of the company, and covers all the personal property of the company, including apparatus, switchboards, dynamos, etc., in Jersey City; Meriden, Conn.; in Cincinnati, O.; in Gloucester, Mass.; in Newark, Camden, Philadelphia, Lancaster, Pa.; Bloomington, Ill.; New York, Baltimore and other places.

The Central and South American Telegraph Company has declared a quarterly dividend of 1¾ per cent., payable Jan. 7, to stock of Dec. 31. The approximate operations for the current quarter are:

Surplus Sept. 30 above October dividends	$304,513
Earnings for quarter	143.711
Operating costs	40,000
Net earnings	$103,711
Dividends payable Jan. 7, '91	84,140
Surplus for quarter	$19,571
Total surplus	324,085

The Mexican Telegraph Company has declared a dividend of 2½ per cent. for the quarter, payable Jan. 14, to stock of Jan. 7. An approximate statement shows:

Surplus Sept. 30 above October dividend	$130,869
Earnings for quarter	96,655
Operating costs	16,000
Balance	$80,655
Other income	3,988
Total income	$84,643
Dividend payable Jan. 14, 1891	47,815
Surplus for quarter	$36,828
Total surplus	167,698

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-177 TIMES BUILDING, NEW YORK, Dec. 29, 1890.

Open House on New Year's.—The New York Electric Club will keep open house on New Year's Day after 12 o'clock noon. A buffet lunch will be served.

Mr. David H. Darrin, general agent of the Steuben Electric Manufacturing Company, Hornellsville, N. Y., has been a welcome visitor in New York City this week.

The Board of Electrical Control has authorized the North New York Electric Lighting Company to erect poles and string wires in 134th and 139th streets.

Mr. A. E. Carrier, the genial representative of the Faraday Carbon Company, of Pittsburgh, Pa., is in New York securing the usual large orders taken at this season of the year.

New Subways Ready.—The electric light companies of this city have been notified that several new subways are now ready for their use. The companies are given 90 days to take down their wires.

New Members of the Electric Club.—At the last meeting of the board of managers of the Electric Club the following-named gentlemen were elected members of the club: John B. Campbell, New York; W. J. Johnston, New York; J. Barre, New York; W. S. Hadaway, Boston, Mass.; John M. Orfond, Bridgeport, Conn.; W B. Cleveland, Cleveland, O.; Theo. Mosher. Chicago, Ill.; Geo. W. Adams, Boston, Mass.; Charles L. Tolles, Hartford, Conn.; H. T. Paiste, Philadelphia, Pa.

New Bids for Electric Lighting.—The Gas Commission opened six now bids for electric street lighting yesterday. They came from the United States, Brush, East River, Mount Morris, Harlem and North New York companies. The former bids had been rejected as excessive. The new ones showed a reduction on an average from 43 to 40 cents per light each night. It is believed that the reduction will bring the cost within the amount which the Board of Estimate is willing to appropriate. There are 1,386 public electric lights in use in the city and 266 in the annexed district.

W. T. H.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 8, Cook Building, cor. Franklin and Congress Sts.
BOSTON, Dec. 27, 1890.

The Bell Lock Electric Conductor Company will add 24 braiders to its force at once.

Mr. Frank Harrington, of the Tropical American Telephone Company, New York, was in town this week, and everybody was glad to see him.

The American Electrical Works of Providence have bought the Goodyear rubber factory, and will use it in the manufacture of a new style of wire to be brought out by them.

Mr. George Cutter of Chicago is in Boston for a week or two picking up specialties for electric light and power plants which he will manufacture in his new factory in the West.

Plans of the Nationalists.—The Boston *Transcript* says that the chief feature of the work of the Nationalists before the Legislature this winter will be an effort to obtain for cities and towns the right to manufacture and sell gas and electricity for lighting purposes. Last year a bill to this effect passed the House, but was defeated in the Senate.

Inspecting the Electric Railway.—Members of the Baltimore City Council, the citizen's committee and the North Avenue Railway Company of that city visited Boston last week for the purpose of inspecting its electric railway system, which it is proposed to introduce there. Friday afternoon, on invitation of the Thomson-Houston Company, the visitors took a ride over the line on a Robinson radial car to Grove Hall, visiting on their return the West End plant and power house. That evening the visitors were entertained at Young's Hotel. Capt. Eugene Griffin, of the Thomson-Houston Company, presided. Mayor Hart extended a cordial welcome to the visitors on behalf of the city of Boston, and remarks were made by several of the visitors and by Boston officials.

L. H. H.

PHILADELPHIA NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
31 CITY BUILDING, PHILADELPHIA, Dec. 27, 1890.

Mr. Wm. Schofield, proprietor of the machine shops on Church street, below Wood, is introducing electric lights in his extensive buildings. The Edison system will be used.

Messrs. O. D. Pierce & Co., agents for the Perkins Electric Lamp Company, of Manchester, Conn., have closed contracts with the central electric light stations to supply them with lamps for the year 1891.

Alfred F. Moore, the well-known wire manufacturer, of this city, has completed the large additions to his factory commenced some six months ago and is making extensive alterations in his offices.

Wilmington, Del.—Mr. I. F. Betts is doing a nice business with his motors in various sizes. Last week he placed a four h. p. motor for the Delaware Printing and Publishing Company, a two h. p. for the Edgemoor Bridge Works, besides several outside the city.

New Electric Road.—It is reported that an electric railway will soon be built between Collingwood and Camden, N. J. E. C. Knight, the sugar refiner, of this city, and ex-Sheriff Tatem, of Camden County, are at the head of the new company. As the charter of the Camden Horse Railroad Company expires at the end of 1890, no opposition to the enterprise will be encountered from that source.

W. F. H.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 THE ROOKERY, CHICAGO, Dec. 27, 1890.

Port Huron, Mich., has in a new fire alarm system.

Eldorado, Kan.—The works of the Light, Heat and Power Company caught fire last week from an explosion of the gas retort and were destroyed, leaving the city without gas or electric light. The loss is $5,000, with no insurance.

Tests of Interior Conduit Tubing.—Messrs. W. A. Willard and H. M. Underwood, representing the Interior Conduit and Insulation Company, of New York, conducted a second very successful test of the tubes manufactured by that company before a number of the leading architects at 65 Washington street, last Monday afternoon. The tests to which the tubes were subjected at the station of the Chicago Edison Company, described in the last issue of THE ELECTRICAL WORLD, were repeated, using in this case wire having the heaviest obtainable insulations. An instance illustrating the fact that combustion cannot take place in a tube occurred during the trial. Two wires having the same insulation were placed in circuit in multiple, one being inclosed in a fireproof tube, the other being left in the open air. Under a heavy overload the insulation on the exposed wire was completely burned away, while that on the wire in the tube was unharmed.

H. C. E.

SPOKANE FALLS, Wash., Dec. 23, 1890.

Farmington, Wash.—The Edison system will be used in the new central station.

Burke, Idaho.—The Tiger mine has purchased a lighting plant of the Edison system.

Gem, Idaho.—The Frisco mine has contracted with the Edison Company for an electric drill plant.

Missoula, Mont.—The Florence Hotel has closed a contract with F. R. Anson for a 400-light Edison incandescent plant,

Mullan, Idaho.—A citizens' company has just closed the contract for a 600 light central station of the Edison company.

Wardner, Idaho.—The "Last Chance" mine is putting in a lighting plant and electric tramway of the Edison system.

MINNEAPOLIS, MINN., Dec. 26, 1890.

Petitioned for Street Railway Line.—The Minneapolis Board of Trade at its last meeting adopted a strong resolution petitioning the Minneapolis Street Railway Company to build an electric line to Fort Snelling, eight miles distant.

The lighting plant of the Grand Forks (N. D.) Electric Company was partially destroyed by fire recently, and considerable damage done to the engines and dynamos. The fire was caused by spontaneous combustion in oily waste.

SOUTHERN NOTES.

NORFOLK, Va., Dec. 27, 1890.

Ft. Worth, Tex.—The poles and wires for the Riverside electric line are being put into position.

Brunswick, Ga.—An isolated incandescent light plant is being installed in Oglethorpe Hotel.

Rome, Ga.—A company is being organized for the purpose of establishing a new electric light plant.

Meridian, Miss.—An isolated incandescent electric light plant is being installed in the St. Charles Hotel.

Mobile, Ala.—The Mobile Street Railway Company is preparing to erect a power house for the operation of its lines by electricity.

Elizabeth City, N. C.—An isolated incandescent electric light plant is being installed in the planing mill of Messrs. G. B. and T. W. Jones.

Athens, Ga.—An isolated incandescent light plant is being installed in the cotton factory of the Athens Manufacturing Company.

Waxahachie, Tex.—The Waxahachie Electric Light Company is putting in new lights daily and will soon have to increase its capacity.

Newport News, Va.—Work is progressing steadily on the new electric line to Hampton and Old Point, and will be in operation by early spring. A portion of the line will commence running shortly.

Decatur, Tex.—The City Council has contracted with the Decatur Electric Light Company to light up the principal business streets of the city. This company has been successfully operating a plant for nearly a year without any assistance whatever from the city.

V. N. B.

ENGLISH NOTES.

(From our own Correspondent.)

LONDON, Dec. 17, 1890.

The Electrical Treatment of Sewage.—A paper was read by Mr. W. Webster, F. C. S., at a meeting of the Society of Chemical Industry on Monday. This gentleman has devoted some ten years to experiments on the problem, which is of vital importance to this metropolis. He has recently carried out some experiments on a very large scale with the sewage of Salford, which is of an exceptionally complex character. He has succeeded in reducing the albuminoid ammonia to .14 parts per 100,000, thus leaving an effluent which may be turned into any stream or river. He uses cast iron electrodes, finding that platinum is too costly, and carbon disintegrates in the presence of nascent oxygen and chlorine. He places the electrodes in a shoot 18 inches deep, two feet wide and 200 feet long. Twenty-five pairs are connected in series, and a pressure of 1.8 volts is used between them. Sir Henry Roscoe had entire control of the experimental works for about a month and found that from 70 to 80 per cent. of the organic matter was precipitated as a sludge. From the experiments on 20,000 gallons of sewage it is estimated that to deal with 10,000,000 gallons in 24 hours at Salford, 400 indicated horse power will be necessary, as for each gallon .37 ampère hour is required. The effluent will be discharged into the Manchester Ship Canal. Experiments made during the lecture on London sewage showed that a flocculent precipitate was formed within a few seconds. If sewage sludge be of any value as manure it should be far more economical to use that which is produced by this process than the product of the well known A. B. C. process, which contains a large quantity of clay, carbon, etc. It is the general opinion among chemists that the chemical experiments which have been made on London sewage are nothing but a costly failure.

Answers to Correspondents.

Questions to be answered in this column must be of general electrical interest, and must be accompanied by real name and address as a guarantee of good faith. No notice will be taken of questions regarding apparatus unless enough details are given to permit a definite answer, and no dynamo or motor designing will be done.

Lamp Rheostats.—In an article on a lamp socket rheostat in THE ELECTRICAL WORLD for Dec. 6, it is stated that with the alternating current distribution it is possible to vary the light of the incandescent lamp by the use of various appliances. Will you please explain what they are? D. T. M.

In general arrangements for inserting a variable self-induction in a lamp circuit, which has the same effect as inserting a resistance without an equivalent loss of energy.

Lamp Filaments.—I notice some of the latest Edison lamps get very hot while burning. I happened to jar one of them tonight and the filament, which was somewhat crooked, struck the side of the lamp and at that point it was not bright for the space of about 1-32 of an inch, although the rest of the filament burned as usual. Why was the filament dark at that point? H. W. L.

Owing to its being cooled immediately at the point of contact with the glass. It is just as if you had cooled a bar of red-hot iron at a particular point by the application of ice; or by touching it with a bar of cold iron.

Incandescent Lamps on Arc Circuits.—(1) How would you calculate the arrangement of incandescent lamps on an arc circuit? (2) How should a given number of 50-volt incandescent lamps be arranged on a 10-ampère Brush circuit? (3) How should a given number of 110 volt lamps be arranged on a 22-ampère lamp circuit? B. T. C.

(1) In general incandescent lamps on arc circuits are placed in parallel with each other, with some special cut-out devices to avoid the danger of breaking them if the current varies seriously. (2) and (3) You had better not attempt to wire up for these yourself, as the lighting companies provide special apparatus for doing this kind of work. It is in most cases not advisable to attempt it; and if light is desired in a situation where arc lights are undesirable, the incandescent lamps for regular series service give admirable results. They are of from 30 to 50 c. p., and take the full arc current, five or more of them being put in circuit as eqivalent of an arc lamp. These series lamps work with fair efficiency, have a good life if the current is properly adjusted, and give the best illumination.

News of the Week.

THE TELEGRAPH.

Lima, O.—The Standard Oil Company has added a quadruplex to its equipment. This gives Chicago a direct wire through to New York and the other side as a duplex to Oil City.

A Long European Line.—A third line of telegraph between Berlin and Rome, 1,210 miles long, is to be constructed through Bavaria and the Tyrol, instead of Switzerland, like the present lines. The wire will be of bronze, and three millimetres in diameter.

Mr. Mackay's Generosity.—Mr. John W. Mackay, following his usual custom, again authorized General Manager Ward to give every employé of the Commercial Cable Company in this country and in Europe, on Dec. 23, half a month's salary as a Christmas present.

Reduction in Rates.—Orders were received Dec. 27 at the Western Union Telegraph Company's headquarters at Kansas City, Mo., making a reduction of rates of from 30 to 40 per cent. on business in Kansas, Nebraska, Colorado and New Mexico, the reduction to go into effect Jan. 1.

Altoona, Pa.—The Western Union Telegraph Company in Altoona, Pa., is to have opposition in the Postal Telegraph Cable Company. For weeks past the postal company has been working its way to Altoona. Offices have been established at Johnstown Hollidaysburg, Ebensburg, Bedford, Huntingdon and other towns near Altoona, and some are already in operation.

International Rates.—The international telegraphic rates on the continent will conform after July 1, 1891, with the schedule fixed by the recent international telegraphic conference in Paris. Between Germany and adjoining countries the rate will be two and a half cents per word, between Germany and Great Britain, Scandinavia or Italy, three and a half cents per word, and between Germany and Russia, Spain or the Balkans, five cents per word.

THE TELEPHONE.

Waltham, Mass.—The New England Telephone and Telegraph Company will extend its lines at this place.

Atlanta, Ga.—The local telephone company is putting in a large number of "nickel-in-the-slot" telephones.

Albany, N. Y.—The Hudson River Telephone Company will construct a double metallic circuit telephone line from Albany to Glens Falls.

Selma, Ala.—The new telephone extension of the Selma & Camden line has been completed to Alberta, and will be further extended to Saffords, and thence to Martin Station, which will be 150 miles.

THE ELECTRIC LIGHT.

Sealed Proposals will be received by the Common Council of Indianapolis, Ind., until Jan. 5 for lighting the city with electricity. A. P. Shawyer is the city engineer.

Elmwood, Ill.—The corporate authorities of this place have contracted with E. R. Brown to put in an electric light plant and supply ten street lights at an expense of $600.

Astoria, Ill.—The village trustees have granted to the firm of Oviatt & Co. a 15-year franchise for an electric light plant, the proposed works to be commenced within six months.

Syracuse, N. Y.—The new "La Concha" building at Syracuse, N. Y., is to have an isolated plant of 300 lights. A Straight Line engine will be used in connection with the Mather incandescent system, for which S. N. Blake, of Elmira, is general agent.

Louisville, Ky.—The Louisville Electric Light Company has just contracted with the Westinghouse Electric and Manufacturing Company for the third increase in the capacity of its alternating current central station electric lighting plant. The company commenced operations about two years ago with a plant containing Westinghouse alternating current apparatus of 1,500 lights capacity. With the latest edition of two 1,500-light Westinghouse alternating dynamos, the plant will have a total capacity of 6,000 16 c. p. incandescent lamps.

THE ELECTRIC RAILWAY.

Escanaba, Mich.—A syndicate is trying to get a franchise for an electric street railway.

Ft. Worth, Tex.—A company is organizing to build an electric line to Brooklyn Heights.

Bedford City, Va.—An electric line will probably be built to the Peaks of Otter, by a company which is now reported organizing.

Sherman, Tex.—Two electric street cars collided at a switch a few days ago, seriously injuring one or two passengers and the motor man.

Baltimore, Md.—The Union Passenger Railway Company having recently acquired possession of the Baltimore, Cantonsville & Ellicott's Mills passenger railway, will probably adopt electricity as a motive power.

Lynchburg, Va.—The Edison Electric Company of New York has been awarded a contract by the Rivermont Company for the construction of an electrical railroad, double track, 3¼ miles in length, and which is to cost $54,000.

Mr. Edmond Verstrate has resigned his position with the Thomson-Houston Company to take charge as electrician and mechanical engineer of the Union Depot Electric Railroad of St. Louis, Mo. Mr. Verstrate is a pioneer in electric railway work, and the operation of the Union Depot system demonstrates that he understands his business.

Charleston, S. C.—It is stated that Eastern parties are trying to buy the Charleston City Railway Company with a view of changing its lines to an electric system. A new Charleston electric street railway enterprise is the West End Railway Company, with a capital stock of $200,000, which has applied to the legislature for incorporation. S. J. Pringle and others are the incorporators.

Electricity Increases the Earnings.—The Pittsburgh *Dispatch*, in reviewing the business of the street railways of that city, says: "The Pleasant Valley electric lines used to run one-horse bobtail cars in 1876, when they only carried 946,721 passengers, earning about $15,000 clear of expenses. In 1886 ten years had only increased this to 1,658,009 passengers, yet the little Pleasant Valley

had audacity to introduce electricity. Last year its cars carried 4,583,900 passengers, the receipts were $231,379, and the expenses were only $153,644."

The Citizens' Traction Company, of Pittsburgh, Pa., a street car corporation which operates about seven miles of cable lines in that city, has decided to extend one branch of its line from Butler street to Sharpsburg for a distance of three miles. This extension will be operated by the electric overhead wire system. The contract for the equipment of the cars with motors has been awarded to the Westinghouse Electric and Manufacturing Company. As the power house will not be completed for some time yet, the road will not go into operation until the spring.

GENERAL APPLICATIONS OF POWER.

An Electric Elevator.—The new Grand Central Passenger Station at Fifth avenue and Harrison street, Chicago, which was recently opened to the public, has 15 stories in its tower, the upper four of these being reached by a special electrical elevator.

Electric Motors in Boston.—The Edison Illuminating Company is at present furnishing current for 504 electric motors having a total capacity of 1,450 h. p. These are run on a 220-volt circuit. During the past month contracts for 72 h. p. have been closed, and the average for the past 18 months has been 50 h. p.

Gatling Guns to be Fitted with Motors.—The Ordnance Bureau of the Navy Department has made a series of exhaustive trials at the Annapolis proving ground of the method of firing Gatling guns by electricity. The electrical apparatus substitutes for the man at the crank a small Crocker-Wheeler motor, by which the gun is fired at any desired speed up to 1,200 shots per minute, requiring only one man to direct the fire. The motor is attached to the breech of the gun and can be instantly detached if injured by a shot and the crank can be used. As a result of the Annapolis trials the Navy Department has decided to have the motors fitted to all Gatling guns on shipboard.

LEGAL NOTES.

For Delinquent Taxes.—A constable in a western city recently chained the armature of a dynamo so that it could not be operated because the company had not paid up all of its taxes to the city.

Mandamus Refused.—Judge Ewing handed down an opinion in Pittsburgh last week refusing a mandamus asked for by the Edison Electric Light Company against the McKeesport Electric Light Company compelling a re-election of officers. The mandamus was refused because it was not asked for according to strict legal procedure.

Storage Battery Patent Suit.—In the suit of the Electrical Accumulator Company against the Brush Electric Company, Judge Brown, of Detroit, filed a decision last Saturday in the United States Circuit Court, at Cleveland, O., in which he denies the petition of the Accumulator Company to dismiss the case. Litigation has been pending in this case for three years.

Minneapolis, Minn.—Judge Young has decided the question of the city of Minneapolis against the Brush Electric Company. The action was to recover from the bondsmen some $2,000 collected of it for the use of lights on Bridge Square while the mast was also lighted. The judge's decision was against the city, as he held that a proper course could have forced the gas company to shut off its lights.

Question of Subway Rentals.—Judge Beach, in the Supreme Court, Chambers, in this city, has signed an order giving the Consolidated Telegraph and Electrical Subway Company leave to amend its answer in the injunction suit brought against the company by a number of electric light companies. The amendment is said to be an offer to lower the rents now charged by the subway company.

A Telephone Injunction.—In the United States Circuit Court in Philadelphia last week, on application of the Bell Telephone Company, decrees were entered restraining Edward, George B., Henry F. and Edward Darby, Jr., John W. Stelwagon, Marcus Sternberg, Andrew J. and Charles S. Blair, Israel Fleishman and Morris and Samuel Lippman from using telephones containing infringements on the Bell patents.

Suit Against the Western Union.—The argument has been finished before Judge Lacombe, in the United States Circuit Court, in this city, in the suit of the United States against the Union Pacific Railroad and Western Union Telegraph companies for about $12,000 paid by the plaintiff to the defendants, which, it is alleged, should have been used in paying part of the bonded indebtedness of the railroad company to the United States. Judge Lacombe reserved the decision which he will instruct the jury to bring in.

Application for a Receiver.—A telegram from Baltimore, Md., says: "In the City Circuit Court Henry E. Lane, one of the bondholders of the Baltimore and Drum Point Railroad Company, filed a petition asking that a receiver be appointed. He claims that no interest has ever been paid on the bonds, and that work on the road has been suspended, that there are no funds to continue, and that unless it is finished by May, 1892, the charter will be forfeited. The bulk of the stock is owned by Edward Lauterbach, of New York, who backed the contractor to the extent of $300,000. The road is about half completed, and Lauterbach will hardly realize on his investment."

Electric Railway Patent Suit.—It is reported from St. Louis, Mo., that the Adams Electric Railway Company, of St. Louis, will within the next two weeks enter suit against the Thomson-Houston, the Sprague, the Short, and other electric railway companies whose systems are now in successful operation, for infringement of patents covering the fundamental principle of propelling cars with electricity. Congressman-elect Seth W. Cobb, Charles F. Orthwein, of Orthwein Bros.; W. M. Samuel, president of the United Elevator Company, and Hugh Rogers, of Hugh Rogers & Co., are at the head of the Adams Electric Railway Company, which is now being reorganized for the purpose of beginning legal proceedings against the other companies referred to. The two Adams patents were applied for in March and December, 1883, and were both granted in June, 1884.

Made a Test Case.—Judge Simonton handed down an opinion last week at Harrisburg, Pa., in the case of the Commonwealth vs. the Brush Electric Light Company, of Philadelphia, in which some important points are discussed and decided. The company claimed to be engaged in manufacturing, and therefore exempt from capital stock taxation under the laws exempting manufacturing companies; also, that the tax on capital stock imposed by the revenue act, passed by the Legislature at its last session in 1889, was wholly unconstitutional because of its lack of equality and uniformity. Another point of minor importance was that stock invested in patent rights granted by the United States is not taxable. This was decided in favor of the company, but upon the others the Commonwealth won. The opinion directs judgment to be entered in favor of the State for $755.60 in this particular case. Although the amount immediately involved is small, it is recognized as a test case and will probably be carried to the Supreme Court.

PERSONALS.

Mr. G. A. Gaebse, director to the Post and Telegraph Department of the German Empire, was at the Post Office Department in Washington last week, in conference with Mr. Wanamaker.

Mr. William S. Barstow, superintendent of the Brooklyn Edison Illuminating Company, is to give a lecture on Jan. 16, 1891, before the Brooklyn Institute, on "An Outline of the Three-Wire Low Tension System."

Mr. Robert S. Dobbie, of the Edison General Electric Company, is announced to deliver a lecture upon "Arc Lighting" before the members of the Brooklyn Institute, on Jan. 30, 1890, in the lecture room of the Brooklyn Y. M. C. A. building.

Mr. James S. Humbird has resigned his position of assistant general manager of the Westinghouse Electric Company. Mr. Humbird will hereafter devote his attention to the affairs of the North American Construction Company, of which concern he is president.

Mr. H. M. Byllesby, vice-president of the Westinghouse Electric and Manufacturing Company, has severed his connection with that organization. Mr. Lemuel Bannister, who has for several years been vice-president of the Fuel Gas and Manufacturing Company, another of the Westinghouse companies, has been appointed to succeed Mr. Byllesby.

Mr. Eugene H. Cowles, of Cleveland, O., has written a letter to the New York *Tribune* in which he advocates the use of the word "alium" as a short form of aluminium. He calls attention to the paper of Mr. Oberlin Smith on "Aluminium in Search of a Nickname," read before the American Institute of Mining Engineers, in which this shortened form was proposed.

Mr. Trafford, the superintendent and electrician of the Richmond Electric Light and Power Company, of Richmond, Va., was presented with a handsome gold watch on Christmas Eve by the employés of the light and power departments as a Chris mas present and a token of their regard and appreciation of the kindness and courtesy he has always shown them.

MISCELLANEOUS NOTES.

The Phonogram is the name of a handsome magazine that has just been issued as the official organ of the phonograph companies of the United States, and is, therefore, devoted to all interests connected with the recording of sound, the reproduction and preservation of speech, the telephone, type-writer and the progress of electricity. It is edited by V. H. McRae, Pulitzer building, this city.

To Make Underground Cables for France.—The Standard Underground Cable Company, of Pittsburgh, has secured a contract from the French Government for the erection of a plant with which to manufacture the underground cables for that republic. A. J. Waring will sail for Paris to begin at once the work The French Government has determined to bury all the wires under its control. The plant which the Pittsburgh concern is to build will turn out about $1,500,000 worth of cable wire yearly. The same corporation is negotiating for the erection of similar works in Berlin.

Industrial and Trade Notes.

Station Accounts.—Wolcott & West, Syracuse, N. Y., manufacture a labor saving ledger that contains many excellent features of interest to the book keeper in central station companies.

Messrs. Palmer Bros., of Mianus, Conn., manufacturers of motors and electro-plating machines, and dealers in general electrical supplies, are making a specialty of furnishing castings for small dynamos and motors for experimental work.

The Northwestern Electric Specialty Company has recently opened an office at 1017 Chamber of Commerce Building, Chicago, and will manufacture novelties of its own design, as well as standard articles, such as push buttons, wall and ceiling cutouts, etc. The manager of this new concern, Mr. Geo. L. Kirkham, expects to begin taking orders within a short time. The company will sell to the trade exclusively.

The Frey Double Break Switch.—The advantages claimed for this switch, which is now put upon the market by the National Electric Company, Limited, are a good bearing contact, giving a full and constant flow of current. Its circular bearing contact gives it more surface, and prevents it from heating. It is easily adjusted; and as it requires no twisting of the wires it can be removed without breaking them, and being a double break it is so constructed as to be free from flashing.

The Steuben Electric Manufacturing Company, of Hornellsville, N. Y., is placing on the market a handsome incandescent dynamo for isolated lighting, and has been quite successful in installing a number of plants, notably, a 250-light plant in the Pitts Agricultural Works, in Buffalo, and a 150-light plant in the old Fillmore mansion in Buffalo, the dynamo in this case being driven by an Otto gas engine. This company is also bringing out a patent lamp socket and combined switch and double pole fuse block.

The Butman Rocking Grate Bar.—This bar seems to be very practical, as it prevents clinkers from clogging it, and it has a shaking arrangement that locks the grate in a level position after using, preventing points sticking into the fire and burning off. Engineers using this style of grate bar speak very favorably of it as a fuel saver Messrs. J. B. Dillingham & Co. are the New England agents, at 243 Franklin street, Boston, and any information can be obtained from them. We understand that the first prize has been awarded them at the Mechanics' fair.

New Company.—Mr. E. T. Birdsall, M. E., and Lemuel W. Serrell, M. E., both gentlemen of large experience in the various departments of electrical engineering, and fully qualified to undertake the development of any electrical enterprise, have organized the B. & S. Electric Equipment Company, with large offices at 115 Broadway, this city. They are bringing out some excellent equipment supplies for electric railways, electric light stations and power plants. They are sole agents in New York for the Russell arc lamp for all systems and also sole agents for American Circular Loom Company's patent woven wires and cables.

Mr. A. B. Laurence, 225 Pearl street, this city, manager of the Shultz Belting Company, is meeting with marked success in the introduction of the Shultz pulley coverings. Hundreds have been put on dynamo pulleys in this section of the country, and the users testify to their great advantages in preventing the slipping of belts. Mr. Laurence has sold over 35,000 feet of Shultz patent fulled leather dynamo belts the past year. Among some of the orders are 300 feet to the New Jersey and Pennsylvania Concentrating Works, Ogden, N. J., Edison system; 150 feet sent to Japan; 200 feet sent to Lakewood Hotel, Lakewood, N. J.; and several hundred feet have been sent to Edison's laboratory.

Of Interest to Dynamo Engineers.—The Jos. Dixon Crucible Company, of Jersey City, N. J., has received a letter from Mr. H. H. McGuire, of the New Berlin (N. Y.) Electric Light and Power Company, in which he says: "Although no one should know of the merits of Dixon's belt dressing better than yourselves, I venture to say that even you would be surprised at the result here. I will only say that we are transmitting 60 to 65 h. p. with a 50-foot American link belt, eight inches wide, running from a 72-inch pulley on driving shaft to a 13-inch pulley on dynamo without any perceptible slip, where slipping means jumping and flickering lights every time." It is claimed that the Dixon belt dressing not only prevents slipping but it preserves the leather.

The Whitcomb Dynamos and Motors manufactured at Worcester, Mass., are rapidly coming to the front. The manufacturer's aim has been to produce dynamos that would prove profitable investments to the purchasers. Electrically their parts are so proportioned as to waste the least possible amount of energy. Armature cores are thoroughly laminated, field-magnet cores are made of the best wrought iron set into the base and the magnetic circuit is short. The Whitcomb motor is of the same general type and appearance as the Whitcomb dynamo. They are said to be highly efficient and perfectly self-regulating and they do not spark under extreme changes of load. They are of very handsome design and finish, but in their construction beauty has been considered as of secondary importance to simplicity, durability and economy of operation.

The Russell Electric Lamp Company has just closed a contract with the Craighead & Kintz Company, of Ballardville, for three years, and this company will manufacture all sizes and styles of the Russell lamp under the immediate supervision of the Russell company. The sale of these specialties will be pushed immediately. The New York office will be at 115 Broadway with the B. & S. Equipment Company. The new lamp of the Russell Electric Company is a model of simplicity. The box is of iron. Brass bridges and brass armature bars have been substituted, which break all magnetic continuity between opposite magnets. There is also insulating material used which insulates these parts from the box and from the coils. The round carbons used by this company are proving very efficient, carbons calculated for 18 hours having recently burned for 25 hours.

The Mason Regulator Company has sent out as unique a Christmas greeting as any it has been our good fortune to receive. At the upper left hand corner is a small sealed package attached to the card, on the outside of which is the word "token." In large letters at the right appear the words "Christmas, 1890." The body of the card contains the following: "At this season of gift-making and general good feeling we want to contribute our share to the festivities and beg your acceptance of this slight token. Not knowing your personal tastes and fearing duplicates of gifts, we send coin (legal tender) and urge you to spend it freely for whatever your inclination dictates, whether for Art, Literature, or Tutti Frutti. Gratify your wants fully; let pleasure have her sway; but avoid foolish extravagance, remembering that 'a penny saved is a penny got.' Wishing you a Merry Christmas and the Happiest of New Years, We are, etc." In the sealed pocket the recipient finds a bright, new penny of 1890. This company has lately shipped several regulators to Karoff, Russia, and is furnishing the United States Navy with reducing valves. The company has also equipped the Auburn Electric Light Company's plant with its devices.

The Hunt Engineering Company has secured the building at 238 Washington street, Brooklyn, in the immediate vicinity of the Bridge. The first floor will be devoted to the general offices, the second to the engineering department, the third to manufacturing, while the basement will be used for supplies and manufacturing, and the cellar for storage. The company will move to the new building Jan. 1. The president, Mr. George W. Hunt, has been interested in electrical engineering since boyhood, and has given practical attention to this department of business for many years. Mr. A. E. Rich, the general manager, has been associated in the successful management of several different electrical enterprises. Mr. Henderson, superintendent of construction, was induced to add his knowledge to the business, as he has rendered valuable service in the engineering of many of the finest plants in the country. Mr. T. J. Fay, manager of supply department, who has had a long experience in the many phases of the manufacture and sale of supplies, will give his attention to the manufacturing department. This company is doing electrical construction work from Maine to the Carolinas. It is completing the plant in the Republican Press Association Building, Concord, N. H.; the East Shore Terminal Company's Cotton Warehouses, Charleston, S. C., and the Jamaica (L. I.) town plant for 1,000 lights of the National Electric Manufacturing Company's alternating system. The company is now manufacturing and selling to the trade a new lamp key and plain socket made specially for the Thomson-Houston lamp. A new socket has also been brought out which fits the Westinghouse lamp. Alexander, Barney & Chapin have taken the general agency for this socket. The company has just brought out some new single and double pole main line switches designed to break the circuit promptly without sparking; also a new line of covered branch blocks and other specialties is under way. Mr. DeWitt N. Cole, who is consulting engineer of this company and prepares all plans for the construction work, was for a number of years with General Newton on the New York Aqueduct.

Business Notices.

Complaints of gas lighting plants stopped by our battery cut-out. Cheap, sensitive, reliable. Electric Supply Company, 105 South Warren street, Syracuse, N. Y.

ST. PAUL, Minn., Dec, 6, 1890.

F. J. Renz, Esq.:

DEAR SIR: The Perret Motor I received from you about six months ago, and have used ever since, is the best I have yet seen. You can use my name in connection with it as you please.

H. WILSON,
Manager The Great Atlantic & Pacific Tea Company.

OFFICE OF MUSCATINE GAS, ELECTRIC LIGHT AND POWER COMPANY, MUSCATINE, Ia., July 15, 1890.

J. A. J. Shultz, St. Louis:

DEAR SIR: In reply to yours of the 9th inst., where you say you think the pulleys are too small to cover your way and make a good job of them, you ought to come up this way and see them; you will then think otherwise. You could not have them back for four times what they cost us. I did the job neatly—beautifully, I might say—and the belt runs lovely.

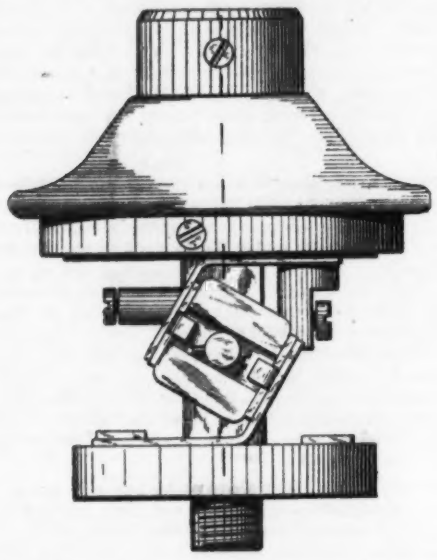
Yours truly,
JAMES HANNAN, Supt.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS

U. S. PATENTS ISSUED DEC. 23, 1890.

443,084. Electric Railway; Edward M. Bentley, of New York. Application filed April 9, 1887. An electric railway having a continuous supply-conductor having exposed contacts at intervals, and a bare conductor composed of insulated sections normally out of circuit with the supply conductor, but adapted to be brought into temporary electrical connection therewith, in combination with a conductor attached to the car traveling in engagement with the contacts, and bringing into electrical connection therewith the bare conductor sections contiguous to the car, this conductor being of a length greater than the distance between the exposed contacts.

443,111. Printing Telegraph; Frank B. Rae, of Chicago. Application filed Aug. 9, 1888. In a telegraph transmitting apparatus, the combination of a number of separate telegraph lines, a converter or induction coil, pole changing apparatus for each line electro-magnetically operated or controlled from a



NO. 443,404.—CIRCUIT BREAKER AND CLOSER.

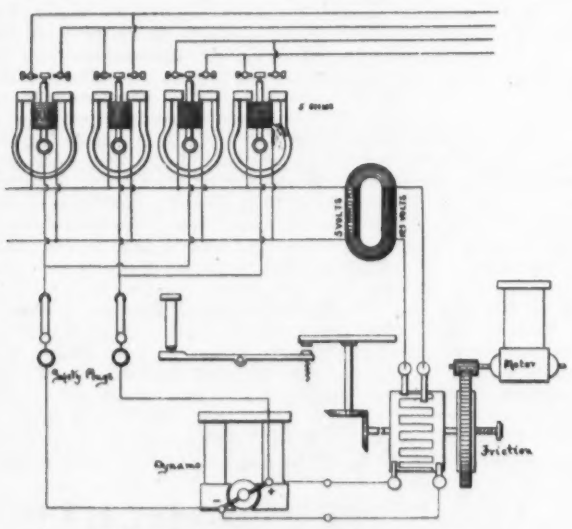
secondary circuit of said converter, carrying to-and-fro or reversed currents supplied from any source, and governed or arrested at any stage by a transmitter common to the lines.

443,134. Printing Telegraph; Samuel Van Buren Essick, of Brooklyn, N. Y. Application filed Nov. 7, 1888. A printing telegraph receiver, having a type wheel driven by a train of gearing, a paper carriage having advancing and restoring mechanism, and a releasing device mechanically connected to one of the gear wheels for automatically releasing the paper carriage at any point of its excursion.

443,135. Printing Telegraph; Samuel V. Essick, of Brooklyn; application filed March 10; a printing telegraph receiver of the Page type, having a type wheel carried by a rotary shaft connected through a sliding unison worm, and pin with a loose-running gear wheel which meshes with a power-impelled train of gear, and a paper carriage geared to a second source of power, in combination with escapements and mechanical connections, whereby the carriage is moved athwart the type wheel, print effected, and the paper advances line by line.

443,136. Printing Telegraph; Samuel V. Essick, of Brooklyn, N. Y. Application filed July 5, 1890. In a printing telegraph, a main line battery, a commutator or pole changer for reversing continuously the battery currents over the line, a power impelled shaft carrying said commutator, an escapement, and an electro-magnet for regulating the rotation of the shaft, and a local circuit, including a local battery, a printing magnet and a circuit breaker operatively connected with the rotary shaft, in combination with a series of key levers for controlling the rotation of the shaft at will.

443,145. Telephone Circuit and Apparatus; James L. McQuarrie, of Boston, Assignor to the New England Telephone and



NO. 443,111.—PRINTING TELEGRAPH.

Telegraph Company, of same place. Application filed June 27, 1890. A metallic circuit extending between a central and two sub-stations, the electromagnetic call bell at the most distant sub-station being included directly in the circuit and that of the intermediate sub-station in a branch circuit diverging from one of the wires at the intermediate station and extending to an earth terminal at the outermost station, a call-sending generator at the central station, and a switch determining by its position the connection of said generator in the metallic circuit for the purpose of individually ringing the bell of the most distant sub station or in an earth-completed circuit including the branch leading through the call-bell of the intermediate station, for the purpose of operating the call-bell.

443,148. Railway Switch Operating System; Samuel L. Powell, of Lewistown, Assignor of one-half to Frederick D. Morrison, of Baltimore, Md. Application filed July 5, 1890. In a railway switch system comprising switch rails, a switch bar and a switch-locking bar, a device for locking and unlocking the switch-locking bar, and electro-mechanical means for shifting the switch and actuating the locking and unlocking device, and including draw-head adapted to be moved by or from a train, connections with the switch bar and the locking and unlocking device, a latch for temporarily engaging the draw-head and connections, an electromagnetic bolt co-operating with the latch, and circuit wires leading from the electromagnetic bolt to contacts on the track, which latter are to be rendered operative from a train.

443,157. Electrical Signaling Apparatus; Ambrose B. Wyckoff, of Washington, D. C., Assignor of three-fifths to Joseph Warren Coulston, of Philadelphia. Application filed May 5, 1890. The combination of a dynamo or other generator of electricity, a lamp or group of lamps, a rotating shaft having projecting arms in different planes, and segments, one for each of the arms, one segment serving to direct the current to the lamp or group of lamps and the other segment shunting the current back to the dynamo.

443,167. Electrically Operated Railway Switch; Samuel L. Powell, of Lewistown, Assignor of one-half to Frederick D. Morrison, of Baltimore, Md. Application filed Feb. 21, 1890. In a railway switch, a switch-bar, a lever connected thereto, rods connected to the lever to move it in opposite directions, a lever-hook pivoted in its support and adapted to be moved towards and engage one or the other of the rods, a rock-shaft in which the lever hook is supported, and means whereby the rock-shaft may be actuated by a passing train, combined with electromagnets arranged at opposite sides of the lever-hook to attract the lever-hook as an armature into engagement with one or the other of the rods, and an electric circuit completed and rendered operative by connection with a passing train, and including the electro-magnets.

443,174. Insulator; William Le Roy, of East Rockaway, N. Y. Application filed Sept. 18, 1890. The combination of a deflected span-wire at or near said points of deflection, an insulator inclosed between said span-wire and said yoke, and a trolley wire suspended from said insulator and by its weight causing the insulator to be firmly gripped between said span-wire and said yoke.

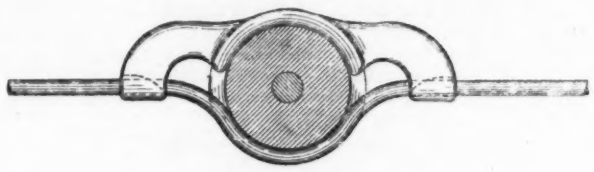
443,181. System of Electrical Distribution; Henry A. Rowland and Louis Duncan, of Baltimore, Md. Application filed Sept. 10, 1888. In a system of electrical distribution, the combination of a source of continuous current of high tension, a circuit extending therefrom, a circuit containing translating devices, and a tension-reducer connected between said high-tension circuit and said translation-circuit and consisting of secondary batteries and a revolving commutator having sets of over-lapping contact-strips, and springs bearing thereon and connected with said circuits and said batteries, whereby the battery-connection with the discharging-circuit and said circuits are both kept unbroken.

443,182. Fire Alarm Box; John J. Ruddick, of Omaha, Neb., Assignor to the Interstate Fire Alarm Company, of same place. Application filed Sept. 13, 1890. In a fire alarm mechanism, the combination of a clock-mechanism, a single lever connected to the clock mechanism for winding the same, and a detent for the clock mechanism arranged in the path of the clock-winding lever, whereby the movement of the latter may directly accomplish the double function of winding the clock mechanism and releasing the detent.

443,187. Electric Insulator; Forée Bain, of Chicago, Ill. Application filed March 25, 1890. An insulator comprising, in combination, a head portion and a petticoat portion, with an intermediate groove for a binder, the petticoat portion having formed upon its outer and inner surfaces a continuous series of separate circumferential sharp ridges.

443,195. Cut-Out; George W. Mingle, of Philadelphia. Application filed Aug. 1, 1890. In combination with an electromagnet and a disengaging arm connected to line and carrying an armature and devices for disengaging this arm upon the attraction of the armature, an auxiliary armature adapted to be attracted by the electromagnet, and a ground connection.

443,219. Galvanic Battery; Horatio J. Brewer, of New York. Application filed June 16, 1890. The combination of a carbon



NO. 443,174.—INSULATOR.

cylinder and a zinc cylinder concentrically arranged and having their open ends embedded in a sealing body of insulating material, forming an electro-negative and electro-positive pole, and an exciting material consisting of a compound of sulphate of lime, chloride of zinc, and glycerine.

443,224. Electric Welding Apparatus; Hermann Lemp, of Lynn, Mass., Assignor to the Thomson Electric Welding Company of Maine. Application filed Aug. 6, 1890. In an electric metal-working apparatus, having fixed current-bearing electrodes making contact with the work, and through or by which the work slides in the welding, upsetting, or other operation.

443,226. Electric Belt; John L. Pratt, of David City, Neb. Application filed May 6, 1890. A cell for electric batteries, comprising an inner coil of copper, a surrounding roll of fabric, the ends of the copper coil clamping the fabric in place and being bent into a hook, a covering of sheet-zinc curved around the roll, the edges being open and the hook protruding therethrough and forming one pole of the battery, and a wire secured inside the sheet opposite the edges and an eye passing through a hole in the sheet and forming the other pole.

443,227. Mounting for Electric Motors; Andrew L. Riker, of New York. Application filed April 23, 1889. A mounting for the propelling-motor of a vehicle, composing in combination a supporting frame or carriage pivoted on one of the axles, springs bearing on a portion of the frame or carriage and pressing in opposite directions, and chains arranged to limit the motion of the frame or carriage and to support it in case of breakage of the springs.

443,282. Electric Safety Device for Elevators; Herbert E. Holmes, of West Springfield, and Charles F. Grosvenor, of Ludlow, Mass. Application filed March 26, 1890. The combination with contact-pieces suitably supported on the floor adjacent the hoist-way, the one having a spring finger, the horizontal bar or part vertically movable and supported from the floor adjacent its edge at the hoistway and provided with a stud, of a power-shipping rod provided thereon with a dog, an electromagnet and wires running therefrom to each of the contact pieces, and one of the wires comprising an electric generator, and a level mounted to swing and to move the shipper-dog and having an operative connection with the electromagnet.

443,283. Electric Safety Device for Elevators; Herbert E. Holmes, of West Springfield, and Charles F. Grosvenor, of Ludlow, Mass. Application filed April 14, 1890. In a safety device for elevators, the combination, with the power shipping medium as the shipper rod of a lever pivotally supported, and a wheel axially mounted for partial rotation, a cord having connections at different points with the power-shipping medium and also with the wheel and cords connected to different peripheral portions of the wheel and to the lever.

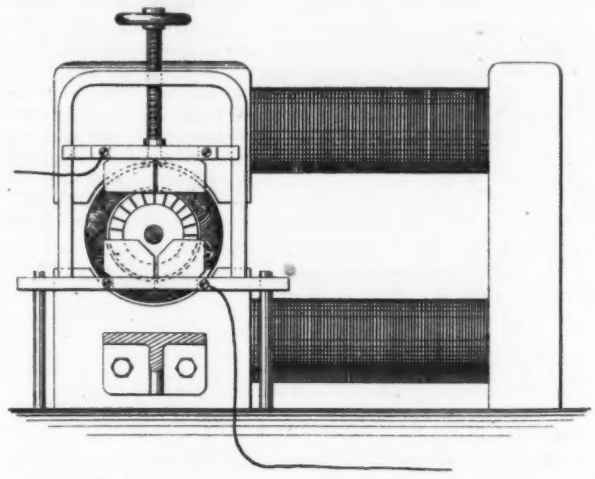
443,381. Telegraph Transmitter; Samuel Wesley Smith, of New York. Application filed June 2, 1890. A telegraph transmitter having a series of vertically moving keys, oscillating carriages having one end beneath the keys and the other provided with a weight, the carriages having segmental racks, shafts mounted in suitable supports, carrying discs having projections thereon corresponding to the characters to be transmitted, means for closing the circuit through said projections, ratchet-wheels fixed to the shafts adjacent to the discs, and pinions mounted loosely upon the shafts so as to mesh with the carriage-racks, the pinions being provided with a pawl to operate the ratchet-wheels.

443,404. Circuit Breaker and Closer; Application filed Aug. 16, 1890. This invention relates to improvements in circuit breakers and closers particularly adapted for use on key sockets for incandescent electric lamps.

443,407. Dynamo-Electric Machine; Charles Paul Scheuritzel and John Ludwig Hess, of Brooklyn. Application filed Feb. 5, 1890. A dynamo-electric machine, having an armature formed of a core and a series of coils, each having the shape of an irregular hexagon, with long and short sides diagonally opposite each other, and with parallel sides of equal length diametrically opposite each other forming the active portions of the coil, the coils alternating in position on the armature core.

443,451. Electric Railway; Rudolph M. Hunter, of Philadelphia, Assignor to the Electric Car Company of America, of same place. Application filed Oct. 4, 1886. The combination of an overhead suspended working-conductor, a surface working conductor, a source of electricity common to both the conductors, an electrically propelled vehicle, an electric motor mechanically connected to rotate the axle, a circuit including the motor, electrically connected with both of the conductors, and a current-regulator in the motor-circuit for controlling the current passing through the motor.

443,452. Electric Railway; Rudolph M. Hunter, of Philadelphia, Assignor to the Electric Car Co., of America, of same place. Application filed Sept. 5, 1890. An electric railway, having two suspended bared working-conductors, arranged one above the other and at different levels from the ground, in combination with a road-bed, a traveling vehicle, a motor on the vehicle, two collectors carried by the vehicle and making electrical contact with the working conductors, two insulated supply-conductors



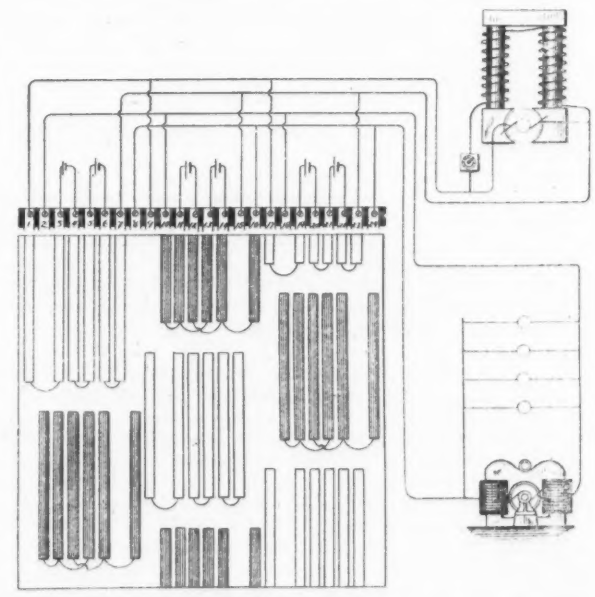
NO. 443,407.—DYNAMO-ELECTRIC MACHINE.

electrically connected at intervals with the working conductors, and a source of electrical energy in connection with said supply-conductors.

443,454. Electrode for Secondary Battery; Isidor Kitsee of Cincinnati. Assignor to Mayer Sulzberger, trustee, of Philadelphia. Application filed Feb. 11, 1890. An electrode for a secondary battery, consisting of an adjustable containing-frame formed of rubber or of other material unsusceptible to the action of electricity or to the acid of the electrolyte and containing active material and a proper conductor.

443,455. Electrode for Secondary Battery; Isidor Kitsee, of Cincinnati, Assignor to Mayer Sulzberger, trustee, of Philadelphia. Application filed Feb. 11, 1890. An electrode for a secondary battery, consisting of a frame formed of rubber or of other material unsusceptible to the action of electricity or to the acid of the electrolyte and containing active material, a conductor formed of any suitable metal and embedded in or placed in contact with the active material, the conductor, when in place between the ends of the piece of rubber, forming the frame, the ends of the frame being bound together by rivets.

443,456. Secondary Battery; Isidor Kitsee, of Cincinnati, Assignor to Mayer Sulzberger, trustee, of Philadelphia. Application filed Feb. 11, 1890. An electrode for a secondary battery, consisting of a containing-frame formed of rubber or of other material unsusceptible to electricity or to the acid of the electrolyte and blocks of active material provided with holes or apertures.



NO. 443,181.—SYSTEM OF ELECTRICAL DISTRIBUTION.

443,457. Secondary Battery; Isidor Kitsee, of Cincinnati, Assignor to Mayer Sulzberger, trustee, of Philadelphia. Application filed Feb. 17, 1890. A secondary battery having a frame formed of a rubber, or other non-conducting material unsusceptible to the electrolyte of the battery, and containing active material to form the negative electrode, the active material forming the electrodes being provided with holes, grooves, or apertures therein, and the electrodes being each connected with a conductor to form the positive and negative poles, respectively, of the battery.

443,478. Fire-Alarm System; Frederick T. Fearey, of Newark, and John Speicher, of Jersey City, N. J., Assignors to the Newark District Telegraph Company of New Jersey. Application filed July 30, 1889. An improved fire-alarm system, combining therein a main circuit having a central station office and its battery, a district alarm box with its controlling magnet, and a fire-engine house and its alarm mechanisms thereon, a shunt extending around the said controlling magnet and having a private box thereon, and an auxiliary line extending from the private box direct to said engine-house, whereby the alarm mechanism of the engine-house is affected to effect an immediate alarm prior to the transmission of an alarm.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired, and address The W. J. Johnston Co., Ltd., Times Building, N. Y.